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AN ANALYSIS OF SPATIAL PRICE DIFFERENCES IN THE NORTH-AMERICAN LIVESTOCK SECTOR*

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TABLE OF CONTENTS

Summary

This paper reports the results of an investigation into spatial price relationships in the North-American livestock industry. The study analyzes the price differences for slaughter steers, slaughter cows, feeder calves, and slaughter hogs, between Eastern Canada, Western Canada, and the US midwest; and the price difference for slaughter lambs between Eastern Canada and the US.

The first part of the report contains an introductory analysis of the price differentials of interest. The approach is descriptive and graphical, and the results show that price spreads have changed over time, in some cases quite drastically. However, trends can be identified for each of the price differences, at least for some subperiods. Also, the period between 1973 and 1975 is somewhat atypical, and virtually all price spreads display considerable short-run volatility.

The second part of the study reports the results of an econometric analysis which illustrates how much of the price spread variability can be explained by a carefully specified econometric model. The competitive spatial price equilibrium model for a single good traded between many regions is briefly reviewed. The special case of two vertically related products, such as hogs and pork, is also presented. This leads to the specification of price linkage equations, which are estimated using quarterly data for the post-1975 period. Several specifications are used for each price linkage, and all equations are estimated using both ordinary least squares and generalized least squares to account for serial correlation in the residuals. The econometric results show that

the performance of the estimated price linkage equations is generally satisfactory, although the implications of the competitive spatial equilibrium model are not always satisfied. Heteroscedasticity of the residuals, which would imply an increased volatility of the price spreads, and seasonality are tested for each equation, and the results indicate that they do contribute significantly to explaining price spreads. The results provide strong support for the hypothesis that price spreads tend to increase as the volume of trade increases, and the predictive accuracy of the equations including the net trade variable is reasonably good.

The last part of the study presents a short-run, three-region normative spatial equilibrium model for slaughter steers and heifers, and hogs. The main features of this type of model are reviewed, and the empirical application postulates constant elasticity demand functions and predetermined supply in each region. The parameters of the model are calibrated to replicate the observed data for 1984, and the model is then used to simulate the short run effects on prices, demand , and trade flows, of exogenous shocks affecting supply, transportation costs, and demand. For the hog model, the simulation exercise includes an analysis of the 1985 US countervailing duty, and some simulations are carried out assuming that transportation costs change as trade flows change, as the econometric findings suggest. The results highlight the nature of the competitive spatial equilibrium model, and illustrate the variability of price spreads between regions that do not trade directly. The concluding section of the paper summarizes the main results, and discusses implications and limitations of the analysis.

1. Introduction

Livestock and meat prices in Canada are largely determined by supply and demand conditions in the much larger United States market. This general observation is of fundamental importance for anyone concerned with the livestock price level in Canada, and especially for the econometric modeling efforts of Agriculture Canada. From the theory of spatial price equilibrium, the implication of the above is that the price in Canada should equal the United States price less transfer costs if Canada is exporting, and should equal the US price plus transfer costs if Canada is importing, where transfer costs are broadly defined as including any cost that must be incurred in moving a commodity between two locations. While this suggests that the relationship between Canadian and US prices in the livestock sector are straightforward, even a casual observation of the evolution of the market in the past few years indicates that this is not the case. Indeed, concerns have been expressed that Canada - US price spreads in the livestock sector have widened in the last few years, and that they have become more unpredictable. These concerns originated this study, and provide the motivation for a detailed analysis of the problem to provide both qualitative and quantitative information useful in understanding and predicting Canada - US price relationships in the livestock sector.

The main objective of this study is to analyze spatial price differentials for: (a) slaughter hogs in Eastern Canada and the US midwest; (b) slaughter steers in Eastern Canada and the US midwest; (c) slaughter cows in Western Canada and the US midwest; (d) feeder calves in Western Canada and the US midwest; and, (e) slaughter lamb in Eastern Canada and the US. To get a more complete picture of US-Canada price relationships in the livestock sector, price differentials between Eastern Canada and the US mid-west for slaughter cows, and between Western Canada and the US mid-west for slaughter steers and hogs are also analyzed. Furthermore, given the relevance of interregional trade in the Canadian livestock market, price differentials between Eastern Canada and Western Canada are included in the analysis. The basing points for the computation of price differentials are: Toronto for Eastern Canada; Calgary (for feeder calves, slaughter steers, and slaughter cows) and Edmonton (for hogs) for Western Canada; and, for the US: Omaha (for slaughter steers and slaughter cows), Kansas City (for feeder calves), US 7-markets (for hogs), and San Angelo, Texas (for lambs).

The first part of the study is dedicated to an introductory analysis of the price differentials of interest. The analysis utilizes graphical techniques, and some simple descriptive statistics to provide an overview of the problem. To move beyond the results of this stage, the second part of the study presents a review of the theory of spatial equilibrium. This highlights the nature of price equilibrium, its use in econometric modeling, and gives precise indications of the data necessary for an empirical implementation of this type of model. This is followed by an econometric analysis of price linkage equations between Canada and the US market. The third part of the study is devoted to constructing a simple normative spatial equilibrium model so as to replicate trade flows for a recent benchmark year. This model uses consensus estimates of the relevant parameters, and illustrates how sensitive interregional price differences and trade flows are to changes in the exogenous variables and parameters of the model.

2. Preliminary Analysis

In this section the price differences mentioned in the introduction are illustrated. The main objective is to provide a descriptive profile of the price differences over the last twenty years. The data used is quarterly data and in most cases it was obtained from Agriculture Canada's computer databank.

2.1. Graphical analysis

The graphs reported in Appendix A give an excellent introduction to price levels and price differences in the livestock sector. Figures A1 to A5 show price levels in the US, Eastern Canada, and Western Canada markets. Figure A1 displays the price of slaughter steers in Toronto, Calgary, and Omaha. For the purpose of making the price series directly comparable, the Omaha price (and all the US prices used in this section) is expressed in Canadian dollars using the quarterly average exchange rate for conversion. Figure A2 shows the price of slaughter cows in Toronto, Calgary, and Omaha, while Figure A3 maps the price of feeder calves in Toronto, Calgary, and Kansas City. Figure A4 graphs the price of hogs in Toronto, Edmonton, and US (7-markets). Finally, Figure A5 shows the prices of slaughter lambs in Toronto and US (San Angelo). The main information that emerges from the figures is the path of the cycle that these markets have experienced in the last twenty years. In the beef sector, the most striking development took place between 1977 and 1979, with the price of slaughter steers doubling from 40 $/cwt to 80 $/cwt (Figure A1), with the other prices in the beef sector (Figures A2 to A4) following suite. For hogs (Figure A4) the price in the three regions displays a general trend upward from the early seventies, but with more pronounced and regular cycles. The prices of lambs (Figure A5) also show an upward trend, which is particularly pronounced between 1977 and 1979, and between 1983 and 1986. While these figures provide information on the general movement of price levels in the period considered, the prices themselves are too close for the figures to shed much light on the evolution of price differences. Thus, Figures A6 to A14 show the actual price differences.

Figures A6 and A7 show the evolution of price differences for slaughter steers. The price difference between Toronto and Omaha was near zero till 1973, when it increased sharply for a couple of years. After that, the price spread has been more stable with the Toronto price generally above the US price. The price difference for slaughter steers between Calgary and Omaha (Figure A6) displays a similar behaviour up until 1975, after which it dips downward as the price in Calgary is generally below both the Toronto and the Omaha price. The price difference between Toronto and Calgary (Figure A7) is always positive, and it displays a strong upward trend since 1974.

The behaviour of price differences for slaughter cows over time, illustrated by Figures A8 and A9, is very similar to the one just described for slaughter steers. The spread between Toronto and Omaha is almost always greater than the spread between Calgary and Omaha. After the steady period 1966 to 1973, and a jump upward around 1974, the Calgary-Omaha spread has moved below zero, while the spread Toronto-Omaha has stayed mostly above zero. The difference in slaughter cow prices between Toronto and Calgary (Figure A9) is almost always greater than zero, oscillating between zero and two $/cwt for the period 1965 to 1976. Since 1978 the spread has widened considerably, with most of the increase taking place between 1978 and 1980.

Figure A10 shows the price difference between Toronto and Kansas City, and between Toronto and Calgary, for feeder calves. Generally, these differences are negative, with Canadian prices being below the American price, except, notably, for a couple of years after 1974. The strongest movement is observed between 1975 and 1979, with a marked movement downward of the price differences. Although the effects of the directions of trade will be dealt with later, the fact that Canadian prices are normally below US prices results from the exporting position of Canada. The price difference between Toronto and Calgary for feeder calves, plotted in Figure A11, is in general positive, except for a considerable decline in 1978 and 1979 when the Toronto price was as much as 13 $/cwt below the Calgary price.

The spread in the hog price between Toronto and US (7-markets), and between Edmonton and US, is reported in Figure A12. The Toronto price was usually above the US price until 1977, while the Edmonton price was below the US price for most of the same period. After 1977 both spreads display a downward trend, which is more accentuated in the period 1983 to 1986. As for the hog price difference between Toronto and Edmonton, Figure A13 shows that the price in Eastern Canada has been above the price in Western Canada for most of the period, although the years 1978 and 1979 are an exception. Finally, Figure A14 illustrates the price difference between the price of slaughter lambs in Toronto and the corresponding price in the US (San Angelo). The price in Toronto is above the US price for most of the period, with a larger than usual value in the second quarter of 1975. A large negative value for the spread is found only in the third quarter of 1985.

The graphs described above suggest three things: (i) trends can be identified in each of the price difference series; (ii) the period between 1973 and 1975, which encompassed the US price freeze, is atypical, with much larger price spreads between the US and Canada than in other years; and (iii) there is considerable short-run variation in the price and price difference series, a volatility that seems to go beyond a seasonal component.

2.2. Price difference levels and variability

The information contained in the above mentioned Figures is summarized, somewhat more rigourously, in the tables of Appendix B. In these tables, the 21 year period from 1966 1 to 1986 3 is separated into 4 subperiods (in some cases, detailed in the tables, the available sample is slightly shorter). For each subperiod, and for the whole sample period, the mean, the variance, and the coefficient of variation of the price spreads are calculated. The mean shows the sign and size of the price spread in each subperiod, while the variance and coefficient of variation give and indication of the volatility of the price spreads. The coefficient of variation is more suitable for comparing the volatility of spreads with different means, but it has the drawback of being ill behaved when the mean of the price spread is close to zero. Two tests of interest are performed and reported in these tables. First, the hypothesis that the mean of the price spread is the same in all subperiods is tested. This is done by comparing the sum of squared residuals of two regressions, one where the price spread is regressed on a constant (which yields the whole sample mean), and one where the price spread is regressed on four dummy variables corresponding to the four subperiods (the estimated coefficients of which are the subperiods means). This leads to a statistic with an F-distribution with (r,n-k) degrees of freedom, where r is the number of restrictions (3 in this case), k is the number of parameters of the unrestricted model (4 in this case), and n is the number of observations of the whole sample (Johnston, 1984, pp.206-207). The second test is a test of variance equality (homoscedasticity) between subsamples which utilizes one of the procedures outlined in Johnston (1984, pp. 298-299).

As for the mean of price differences, the hypothesis of constancy between subsamples is not rejected (at the 5% probability level) only for the spread of slaughter cow prices between Toronto and Omaha. The hypothesis of variance constancy between subperiods (again, at the 5% probability level) is not rejected only for the price differences of slaughter cows between Toronto and Omaha, for feeder calves between Calgary and Kansas City, and for slaughter lambs between Toronto and San Angelo. These simple tests confirm what the earlier graphical analysis suggested, that there is significant variability in both the size and volatility of the price spreads in the time period considered, and suggest that more analysis is required to understand the behaviour over time of the spatial price spreads in the livestock sector.

3. An econometric analysis of price linkages

This section presents a rigorous econometric analysis of the price spreads of interest. Before analyzing the econometric specification and estimation of price spread, however, it is necessary to review briefly the theory of competitive spatial price equilibrium.

3.1. Competitive statial price equilibrium

The "law of one price" is one of the main principles of the theory of international trade. It is really an equilibrium condition, which says that, with no transportation costs or other barriers to trade, the price of a good in an open market equilibrium must be the same for all trading countries or regions (Caves and Jones, 1985). This will make the trading decisions of the countries involved compatible (total demand equals total supply, and total exports equal total imports), and the solution will be an equilibrium solution in that no further spatial arbitrage possibility exists. If trade is affected by the existance of transportation costs, the law of one price is only trivially affected. Equilibrium still requires prices between any two trading regions to differ by exactly the transportation cost, and prices between any two non-trading regions (in open equilibrium) to differ by less than the transportation cost. Tariffs and other barriers to trade can be accounted for in this framework, since they can be thought of as additional costs that have to be incurred in moving a commodity between any two locations.

More formally, the competitive spatial equilibrium conditions can be represented as:

(1) $S_i(P_i) = \Sigma_j X_{ij}$

(2) $D_j(P_j) = \Sigma_i X_{ij}$

(3) $P_j = P_i \qquad i = j$

(4) $P_j = \text{minimum}_{(i)} \{ L_j(P_i) : 0 < X_{ij} < Q_{ij} \} \qquad i \neq j$

with:

(5) $P_i, P_j > 0$

(6) $S_i \geq 0$

(7) $D_j \geq 0$

(8) $X_{ij} \geq 0$

where: $i = 1,\ldots,N$ indexes regions at the supply level;

$j = 1,\ldots,N$ indexes regions at the demand level;

P_k = Price in region k (k=i,j);

S_i = Supply in region i;

D_j = Demand in region j;

X_{ij} = Trade flow from region i to region j;

$L_j(P_i)$ = Price linkage between P_j and P_i;

Q_{ij} = Upper limit for trade flow X_{ij}.

Note that when i and j index the same region, then X_{ij} is the amount of supply consumed domestically. The price linkage function is of fundamental importance, because it reflects the effects of transportation costs, exchange rate, import tariffs (or subsidies), and export taxes (or subsidies). A general version of the price linkage is:

(9) $$P_j \equiv L_j(P_i) = \{[P_i*(1+t_i)+T_i+C_{ij}]*E_{ij}\}*(1+t_j)+T_j$$

where: t_i = ad-valorem export tax (negative if subsidy);

T_i = specific export tax (negative if subsidy);

C_{ij} = transportation costs between i and j (in currency i);

E_{ij} = exchange rate converting currency i into currency j;

t_j = ad-valorem import tariff (negative if subsidy);

T_j = specific import tariff (negative if subsidy).

It should be emphasized that the equilibrium conditions shown above pertain to a static, perfect competive trade model, which assumes a homogeneous good (consumers in any one region are indifferent as to the source of the product), perfect information, timeless and frictionless adjustment, and competitive behaviour of the trading countries.

3.2. Spatial equilibrium with interrelated goods

While for the sake of clarity the spatial equilibrium conditions have been formalized for a single good produced and consumed in many regions, they are essentially the same when considering more than one market simultaneously. In a general equilibrium, the equilibrium price in any one market is obviously affected by demand and supply conditions in other markets. The spatial configuration of prices in any one market, however, will obey the same linkage conditions described for a single product, since the underlying principle is still the exaustion of spatial arbitrage possibilities. This case is very relevant to the problem of price relationships in the livestock sector, since trade of livestock product occurs along with trade in meat products, and the two market levels are highly interrelated. To illustrate this point an example is utilized. Consider two interrelated products, say hogs and pork, and let x denote the quantity of hogs, y the quantity of pork, w the price of hogs, and p the price of pork. Furthermore, let :

$x = x(w)$	supply of hogs
$y = y(p)$	demand of pork
$z = z(w,p)$	demand of hogs / supply of pork

In a closed market, with hogs and pork measured in the same units, the equilibrium prices of hogs and pork (w°,p°) will solve the market equilibrium conditions at the two market levels:

$$x(w) = z(w,p)$$

$$z(w,p) = y(p)$$

In an open market the equilibrium conditions are similar. For instance, considering only two countries (A and B), so that an analytical solution can be found without requiring numerical optimization, with no transfer costs the market equilibrium conditions are:

$$x_A(w) + x_B(w) = z_A(w,p) + z_B(w,p)$$

$$z_A(w,p) + z_B(w,p) = y_A(p) + y_B(p)$$

That is, the total supply of hogs must equal the total demand for hogs in the two countries, and the total supply of pork (equal to the demand for hogs, given the same unit of measurement) must equal the final demand for pork in both countries, and these equilibrium conditions will solve for the open market clearing prices (p^*,w^*).

A numerical example will drive home the main point. Assume:

$$x_A = 2\,w$$

$$x_B = w$$

$$y_A = 15 - p$$

$$y_B = 15 - p$$

$$z_A = 15 - 6\,w + p$$

$$z_B = 15 - 5\,w + p$$

Note that in this example the two countries have the same final demand.

Country A is more efficient in the production of hogs, and country B is more efficient in the transformation of hogs into pork. The equilibrium conditions for this example are:

$$2w + w = 30 - 11w + 2p$$

$$30 - 11w + 2p = 30 - 2p$$

which when solved give the equilibrium solution:

$$w^* = 60/17$$

$$p^* = 165/17$$

These equilibrium prices imply the following equilibrium quantities:

country A :	$x^* = 120/17$	$z^* = 60/17$	$y^* = 90/17$
country B :	$x^* = 60/17$	$z^* = 120/17$	$y^* = 90/17$

Note that country A exports 60/17 units of hogs, while it imports 30/17 units of pork, while country B imports 60/17 units of hogs and exports 30/17 units of pork. Thus, if we consider the total net trade position for the hog/pork sector, country A is a net exporter and country B is a net importer. Notwithstanding this, the prices in the two countries are exactly the same because of the absence of transportation costs. The moral of the story is that whether a region will have a price above or below that of a trading partner will only depend on the direction of trade of the good being considered, and not on the direction of trade of related products.

3.3. Application to the livestock industry

As shown in the preceding theoretical review, the spatial equilibrium competitive model gives rise to two basic propositions: (1) the direction of price differences between two trading regions depends on the direction of trade, and (2) the size of price differences will be affected by transportation costs, tariffs and subsidies, and exchange rates. Before exploring the implications of these two propositions for the livestock market, data requirements must be addressed.

3.3.1 Data requirements

As equation (4) and (9) suggest, to analyze price linkages we need information on regional prices, on the directions of trade, on tariffs and subsidies, on the exchange rate, and on transportation costs. Prices in Western and Eastern Canada, and in the US, are readily available for selected locations. For slaughter steers, the prices used are the weighted average price of slaughter steers (A1,2), 1000 Lbs and over, in Calgary and Toronto, and the price of slaughter steers, choice, 900-1100 Lbs, in Omaha. For slaughter cows, we used the weighted average price of slaughter cows (D1,2) in Calgary and Toronto, and the price of utility cows in Omaha. For feeder calves, we used the price of feeder steer calves (graded), 500-600 Lbs, in Calgary and Toronto, and the price of feeder steers, medium No. 1, 400-500 Lbs, in Kansas City. For hogs, the prices used are the weighted average price of hogs index 100 dressed at marketing board, in Alberta and Ontario, and the hog price, barrows and gilts 7-markets, in the US. Finally, the prices used for slaughter lambs are the weighted average price of lambs (A and B), 80-100 Lbs, in Toronto, and the price of slaughter lambs, choice, in San Angelo.

The directions of trade for the commodities of interest, and for the three regions to be analyzed, are illustrated in Tables 3 to 7. Western Canada net exports to the US in the beef sector are reported in Table 1. Over the period analyzed, Western Canada has virtually always been a net exporter of beef meat, and of slaughter bulls and cows, while a mixed record is displayed for slaughter steers and heifers. In this group, Western Canada was a net importer for the period 1970 to 1978, while it has been a net exporter since 1979. Western Canada has always been a net exporter to the US of feeder calves and cattle, partly due to the fact that imports of feeder cattle from the US are virtually precluded. Table 2 gives the same information for Eastern Canada. Again, Eastern Canada is virtually always a net exporter to the US of beef meat, and of slaughter cows, while the opposite is true for slaughter steers. Eastern Canada is also a net exporter of feeder cattle to the US, although the shipments are very small. The net export position to the US of Canada as a whole in the beef sector is reported in Table 3. Canada is always a net exporter of beef meat, slaughter bulls and cows, and feeder calves and cattle to the US. For slaughter steers, Canada was a net importer for the period 1970 to 1983, while in the last two years it has moved back to the net export position of the late sixties.

Canadian net exports to the US in the pork sector are illustrated in Table 4. Due to the fact that live hog imports from the US are virtually precluded by health regulation, both regions are net exporters of hogs to the US, although these exports have become sizable only in the 1980's. Both Canadian regions experienced a deficit position in pork around the mid-1970's, which has however turned into a clear export position since 1980. As for intra-Canada trade, Table 5 shows that the direction of trade is consistently from West to the East. The bulk of

Table 1 - Western Canada Net Exports to the U.S. in the Beef Sector

	dressed meat	slaughter steers & heifers	slaughter bulls & cows	total	feeder calves & cattle
	------- mill. lbs. carcass weight			-------	000's
1966	20.5	-1.0	42.9	62.4	280.0
1967	6.0	-4.8	6.9	8.1	120.8
1968	10.9	4.3	23.2	38.3	111.1
1969	6.5	5.8	16.5	28.8	12.8
1970	16.0	-1.5	4.5	19.0	4.6
1971	10.9	-4.0	-8.3	-1.5	11.0
1972	2.1	-7.0	1.7	-3.2	54.0
1973	2.1	-29.7	19.0	-8.5	118.7
1974	2.2	-15.9	0.7	-13.0	12.8
1975	-0.1	-4.4	62.4	57.8	28.8
1976	25.2	-8.7	102.4	118.9	58.7
1977	24.9	-2.5	106.8	129.2	140.1
1978	22.4	-7.5	77.7	92.6	62.8
1979	21.6	1.5	41.8	64.9	28.7
1980	17.5	2.4	49.4	69.3	32.6
1981	33.4	4.5	43.6	81.5	34.9
1982	45.8	24.5	64.3	134.6	71.4
1983	51.0	28.4	42.1	121.6	7.8
1984	60.2	65.0	49.1	174.3	4.9
1985	98.9	43.4	59.0	201.3	59.7

Source: Agriculture Canada databank.

Table 2 - Eastern Canada Net Exports to the U.S. in the Beef Sector

	dressed meat	slaughter steers & heifers	slaughter bulls & cows	total	feeder calves & cattle
	------- mill. lbs. carcass weight -------				000's
1966	16.7	4.0	10.0	30.7	2.2
1967	-1.9	-4.4	3.0	-3.3	0.8
1968	27.0	8.2	3.0	38.2	1.5
1969	47.5	10.4	3.1	61.0	0.8
1970	95.5	-1.5	7.7	101.7	2.1
1971	53.6	-12.3	12.1	53.4	5.8
1972	28.4	-12.8	10.5	26.1	4.8
1973	29.6	-88.6	19.8	-39.2	9.1
1974	31.7	-45.8	3.8	-10.4	1.8
1975	25.5	-7.8	-1.0	16.7	1.1
1976	57.4	-38.1	1.9	21.3	4.8
1977	58.6	-0.0	17.2	75.8	2.9
1978	42.4	-22.7	37.4	57.1	10.1
1979	67.6	-10.8	39.7	96.5	10.6
1980	91.7	-31.2	31.9	92.4	9.3
1981	95.0	-82.3	19.5	32.2	11.0
1982	91.0	-39.3	34.6	86.4	9.7
1983	81.9	-41.6	54.5	94.8	6.8
1984	97.2	-10.9	32.1	118.4	2.2
1985	84.8	-29.7	35.6	90.7	4.6

Source: Agriculture Canada databank.

Table 3 - Canada Net Exports to the U.S. in the Beef Sector

	dressed meat	slaughter steers & heifers	slaughter bulls & cows	total	feeder calves & cattle
	------- mill. lbs. carcass weight -------				000's
1966	37.2	3.0	52.9	93.1	282.2
1967	4.1	-9.2	9.9	4.8	121.6
1968	37.8	12.5	26.2	76.5	112.5
1969	54.0	16.2	19.6	89.8	13.6
1970	111.5	-3.0	12.2	120.7	6.8
1971	64.5	-16.3	3.8	52.0	16.8
1972	30.5	-19.8	12.2	22.9	58.8
1973	31.7	-118.2	38.9	-47.7	127.8
1974	34.0	-61.8	4.5	-23.3	14.6
1975	25.3	-12.2	61.4	74.6	29.9
1976	82.6	-46.8	104.4	140.2	63.5
1977	83.4	-2.5	124.0	204.9	143.0
1978	64.7	-30.2	115.1	149.7	73.0
1979	89.3	-9.3	81.5	161.5	39.4
1980	109.2	-28.8	81.3	161.7	41.9
1981	128.3	-77.8	63.1	113.7	45.9
1982	136.8	-14.8	98.9	221.0	81.1
1983	132.9	-13.2	96.6	216.4	14.5
1984	157.4	54.2	81.2	292.7	7.1
1985	183.7	13.7	94.6	292.0	64.2

Source: Agriculture Canada databank.

Table 4 - Canada Net Exports to the U.S. in the Pork Sector
millions of pounds in carcass weight

	Western Canada			Eastern Canada			Canada		
	pork	hogs	total	pork	hogs	total	pork	hogs	total
1966	14.5	na	na	3.8	1.4	5.2	18.3	na	na
1967	23.4	1.0	24.4	3.8	1.6	5.4	27.2	2.6	29.8
1968	22.7	1.1	23.8	-3.9	1.7	-2.2	18.8	2.8	21.5
1969	14.4	1.4	15.8	-32.0	0.8	-31.2	-17.6	2.2	-15.4
1970	35.8	8.4	44.2	1.2	3.4	4.7	37.0	11.8	48.8
1971	49.4	8.9	58.3	4.9	2.9	7.7	54.3	11.8	65.8
1972	37.4	9.9	47.3	-9.8	1.8	-7.9	27.7	11.7	39.2
1973	35.8	9.5	45.3	-10.1	2.5	-7.7	25.6	12.0	37.4
1974	13.6	21.9	35.6	-28.3	4.2	-24.1	-14.7	26.1	11.4
1975	-16.3	2.3	-14.1	-46.4	1.8	-44.6	-62.7	4.1	-58.7
1976	-67.5	3.3	-64.2	-102.2	2.7	-99.5	-169.7	6.0	-163.7
1977	-78.3	3.5	-74.8	-97.6	2.2	-95.4	-176.0	5.8	-170.2
1978	-40.5	17.1	-23.5	-26.4	8.8	-17.6	-67.0	25.9	-41.1
1979	-16.9	8.5	-8.4	37.7	9.5	47.2	20.8	18.0	38.8
1980	8.5	25.7	34.1	124.9	6.6	131.5	133.4	32.3	165.9
1981	10.3	15.7	26.0	124.7	4.4	129.1	135.0	20.1	155.2
1982	25.4	28.0	53.4	194.6	14.0	208.5	219.9	42.0	262.2
1983	26.7	41.7	68.4	183.2	21.6	204.9	210.0	63.3	273.9
1984	69.4	98.6	168.1	226.2	88.2	314.4	295.7	186.8	482.6
1985	114.3	76.3	190.6	246.9	83.8	330.7	361.2	160.1	521.7

Source: Agriculture Canada databank.

Table 5 - Western to Eastern Canada Livestock Shipments

	slaughter steers & heifers	slaughter bulls & cows	feeder calves & cattle	hogs
	---------- 000's			----------
1966	125.2	4.1	391.7	2.4
1967	116.6	16.3	484.1	1.5
1968	145.7	0.0	444.5	2.1
1969	127.3	1.0	384.5	2.1
1970	120.0	8.3	338.5	4.7
1971	74.2	17.1	331.6	4.0
1972	88.1	10.1	379.6	12.4
1973	69.5	7.8	339.7	7.7
1974	130.7	25.8	337.1	30.7
1975	145.3	13.3	429.7	6.6
1976	65.0	0.0	334.7	2.2
1977	45.8	0.0	245.3	1.6
1978	28.4	0.0	634.1	0.4
1979	13.2	0.0	516.0	0.7
1980	41.5	0.0	669.1	22.6
1981	36.6	0.0	514.9	19.1
1982	42.7	0.0	601.4	17.8
1983	24.1	0.0	507.2	9.7
1984	42.8	0.0	503.3	0.6
1985	15.6	0.0	476.5	8.3

Source : Agriculture Canada Databank.
Agriculture Canada, Livestock Market Review (hog data)

the livestock flow is represented by feeder calves and cattle, and to a lesser degree by slaughter steers. Shipments of live hogs only sporadically have reached a sizable level.

Another set of data necessary for the empirical application of the spatial equilibrium model is tariffs. Table 6 reports the relevant US tariffs on livestock imports from Canada, while Table 7 reports the Canadian MFN tariffs, that apply for imports from the US. It seems clear that the tariff structure between the two countries has never constituted a major barrier to trade. Tariffs are low, and generally the same in both directions. The time profile of these tariffs shows two periods of progressive liberalization, following the agreements of the Kennedy and Tokyo rounds of multilateral trade negotiations. The only relevant exception to this picture is represented by the countervailing duty on US imports of hogs from Canada, imposed in March 1985 and currently in effect following the confirmation in July 1985. The size of this duty (4.39 Canadian cents per pound) can already be seen in the 1985 trade figures, with Canadian hog exports to the US declining by 17 million pounds relative to 1984, and the pork exports increasing by 65 million pounds (Table 4).

Of the remaining data relevant to the analysis of price spreads, the exchange rate between Canada and the US is easily obtained, but transportation cost data poses serious problems. While one can get reasonable estimates of current transportation rates for a variety of products and transportation forms, consistent historical time series are difficult to assemble. Table 8 illustrates some of the series that we have gathered. For Canada, railroad rates dating back to 1972 are available. For the US we have records of a rail freight index since

Table 6 - U.S. Tariffs on Livestock Imports from Canada

	Cattle			Hogs	Sheep & Lambs
	under 200 lbs.	200-699 lbs.	above 700 lbs.		
	cents per pound				cents/head
	(a)		(b)	(c)	
1966	1.5	2.5	1.5	1.0	75
1967	1.5	2.5	1.5	1.0	75
1968	1.5	2.5	1.5	0.9	60
1969	1.5	2.5	1.5	0.8	45
1970	1.5	2.5	1.5	0.7	30
1971	1.5	2.5	1.5	0.6	15
1972	1.5	2.5	1.5	0.5	free
1973	1.5	2.5	1.5	0.5	free
1974	1.5	2.5	1.5	0.5	free
1975	1.5	2.5	1.5	0.5	free
1976	1.5	2.5	1.5	0.5	free
1977	1.5	2.5	1.5	0.5	free
1978	1.5	2.5	1.5	0.5	free
1979	1.5	2.5	1.5	0.5	free
1980	1.3	2.0	1.3	free	free
1981	1.1	1.5	1.1	free	free
1982	1.0	1.0	1.0	free	free
1983	1.0	1.0	1.0	free	free
1984	1.0	1.0	1.0	free	free
1985	1.0	1.0	1.0	4.39	free
1986	1.0	1.0	1.0	4.39	free

Notes: (a) If above quota of 200,000 head/year, the tariff is 2.5 c/lbs for the period 1966-1979, 2.0 c/lbs for 1980, and 1.5 c/lbs for 1981.

(b) If above quota of 400,000 head/year, the tariff is 2.5 c/lbs for the period 1966-1979, 2.0 c/lbs for 1980, and 1.5 c/lbs for 1981.

(c) For 1985 and 1986, 4.39 (Canadian) is the countervailing duty imposed on 27 March 1985 and confirmed 27 July 1985.

Source: Agriculture Canada, Livestock Market Review, various issues.

Table 7 - MFN Canadian Tariffs on Livestock Imports

	Cattle	Hogs	Sheep & Lambs
	---- cents/lbs.	----	$/head
	(a)	(b)	
1966	1.5	1.0	2.0
1967	1.5	1.0	2.0
1968	1.5	0.9	2.0
1969	1.5	0.9	2.0
1970	1.5	0.5	2.0
1971	1.5	0.5	2.0
1972	1.5	0.5	2.0
1973	1.5	0.5	2.0
1974	1.5	0.5	2.0
1975	1.5	0.5	2.0
1976	1.5	0.5	2.0
1977	1.5	0.5	2.0
1978	1.5	0.5	2.0
1979	1.5	0.5	2.0
1980	1.3	free	1.5
1981	1.1	free	1.0
1982	1.0	free	1.0
1983	1.0	free	1.0
1984	1.0	free	1.0
1985	1.0	free	1.0
1986	1.0	free	1.0

Notes: (a) Free from February to September 1973.
(b) In 1969 the tariff was 0.5 from June onward. Free from February to December 1973.

Source: Agriculture Canada, Livestock Market Review, various issues.

Table 8 - Transportation Costs Indicators for Canada and the U.S.

	Canada				United States		
	Rail (a)	Rail (b)	Rail (c)	CPI (d)	Rail (e)	Truck (f)	CPI (g)
1966	na	na	na	36.2	na	na	na
1967	na	na	na	37.1	na	na	100.0
1968	na	na	na	37.9	na	na	103.0
1969	na	na	na	38.9	na	na	106.5
1970	na	na	na	40.3	na	na	111.1
1971	na	na	na	41.9	na	na	116.6
1972	3.47	881	3.50	43.0	na	na	117.5
1973	3.47	881	3.50	44.4	na	na	121.5
1974	3.47	881	3.50	48.9	na	na	136.5
1975	4.64	1198	4.62	54.6	45.2	na	149.7
1976	4.91	1395	5.09	60.1	49.8	na	164.6
1977	5.31	1411	5.16	64.4	53.1	na	176.6
1978	5.49	1529	5.39	68.2	56.8	na	185.0
1979	5.60	1583	5.76	74.9	64.7	na	212.3
1980	6.52	1786	6.47	84.1	76.2	92.9	249.1
1981	7.29	1964	7.40	100.0	87.4	95.5	277.5
1982	6.99	1980	8.51	113.4	93.8	100.3	287.5
1983	6.85	1998	9.02	118.7	94.9	100.3	293.9
1984	7.33	2097	9.39	123.1	99.3	107.8	314.1
1985	7.60	2216	9.82	128.4	100.0	106.9	314.2
1986	7.82	2270	9.85	129.9	101.0	110.6	299.5

Notes:
(a) Freight rate ($/cwt), single deck shipments of livestock from Swift Current, Sask., to Midhurst, Ont.
(b) Freight rate ($/car), single deck shipments of livestock from Calgary to Toronto.
(c) Freight rate ($/cwt), shipments of dressed meat (minimum weight 60,000 lbs), Calgary to Toronto.
(d) Private transportation component of the CPI, 1981=100.
(e) Price index of railroad freight in the U.S., 1985=100.
(f) Truck rates (cents/mile) for hauling produce from Imperial Valley, CA to New-York.
(d) Private transportation component of the CPI in the U.S., 1967=100.

Source:
(a) Canadian Freight Association, Eastbound Tariff.
(b) and (c) Alberta Agriculture, Agricultural Transportation, Vol. X, September 1986.
(d) Statistics Canada.
(e) and (g) U.S. Department of Commerce, Survey of Current Business.
(f) U.S. Department of Agriculture, Office of Transportation.

1975, and long-haul truck rates since 1980. In the absence of good transportation rates, we have assumed that transportation costs are correlated with the private transportation component of the consumer price index, which reflects the evolution of fuel prices and other operating expenses. This item of the CPI is reported for both Canada and US in Table 8, and it is the only one that allows a long time series perspective.

3.3.2 Direction of price spreads

As was pointed out earlier, the two main implications of a spatial equilibrium model concern the sign and size of spatial price differences. A first check of the applicability of the spatial equilibrium model, therefore, can be obtained from an analysis of the sign of price spreads vis-a-vis the direction of trade. The results of this analysis are reported in Table 9. For each of the price differences of interest, Table 9 shows the number of observations consistent with the predictions of the spatial equilibrium model. An observation is defined as consistent if the price difference between the exporting and importing region is negative, after exchange rates and custom duties are accounted for in the calculation of the price differences. To get an idea of the seriousness of inconsistent observations, the last column of Table 9 reports a "degree of violation", which is defined as the highest volume of trade for the observations which violate the criterion over the highest volume of trade over the whole observation period. When this coefficient is small, it signifies that the violations on the sign of price differences take place in quarters characterized by a level of trade close to the no trade situation, and are consequently less damaging to the applicability

Table 9 - Consistency with spatial equilibrium model

		period	C	I	V
Slaughter steers	EC-US	66 1-86 3	47	36	0.14
		78 2-86 3	21	13	0.25
	WC-US	67 1-86 3	47	32	0.47
		81 3-86 3	21	0	0.00
	EC-WC	66 1-86 3	83	0	0.00
		76 1-86 3	43	0	0.00
Slaughter cows	EC-US	66 1-86 3	3	80	1.00
		77 1-86 3	1	38	1.00
	WC-US	67 1-86 3	31	52	0.47
		76 1-86 3	25	18	0.57
Feeder calves	WC-US	66 1-86 3	52	31	0.55
		76 1-86 3	32	11	1.00
	EC-WC	66 1-86 3	55	28	1.00
		76 1-86 3	23	20	1.00
Hogs	EC-US	66 1-86 3	29	54	0.05
		82 1-86 3	19	0	0.00
	WC-US	67 1-86 3	53	26	0.25
		80 1-86 3	26	1	0.08
	EC-WC	73 1-85 4	48	4	0.10
		80 1-85 4	23	1	0.10
Slaughter lambs	EC-US	68 1-86 3	64	11	0.33
		76 1-86 3	37	6	0.33

Legend : C - number of consistent observations;
I - number of inconsistent observations;
V - degree of violation (see text).

of the spatial equilibrium conditions.

The results in Table 9 are mixed. For slaughter steers and hogs the results are broadly consistent with the prediction of the competitive spatial equilibrium model. This is especially so when the analysis is carried out on the most recent period characterized by unidirectional trade flows, and which leaves out the turbulent years 1973-1975. For slaughter steers the cleanest results emerge for Western Canada to US and to Eastern Canada price differences, while for hogs the best results are for the price differences between Eastern Canada and US, and between Western Canada and the US. For slaughter cows and feeder calves the results in Table 9 are somewhat perplexing. A number of observations violate the consistency check, even for the most recent period, and the violations are not confined to periods of low trade. This raises the question of whether the measured prices really refer to the same commodity and to the same market level in all regions, as required by the competitive spatial model. Finally, for slaughter lambs the majority of the observations are consistent with the price spread, although some inconsistent observations exist.

It should be clarified at this point that the prediction checked in the above analysis is valid only for prices between points that are actually trading with each other. This is obviously the case for Western and Eastern Canada, and a reasonable approximation for commodities being imported in Canada from the US, while it may not be the case for price spreads of commodities exported to the US, since the reference price in the US is observed in a surplus region (the midwest). While this point deserves more thought, for the time being it may absolve some of the price spreads (in particular those of Western Canada to the US) from conforming fully to the predictions of the partial equilibrium model. This leaves room for a regression analysis of price spreads, even without a full satisfaction of the direction of price spreads, and to this the next section is dedicated.

3.3.3. Price linkage equations

For the case of livestock products in the North-American market, the price linkage equation (9) can be simplified to:

$$(10) \qquad P_j = P_i E_{ij} + T_j + C_{ij} E_{ij} \qquad \text{for } X_{ij} > 0$$

or:

$$(11) \qquad P_j = (P_i - T_i) E_{ij} - C_{ji} \qquad \text{for } X_{ji} > 0$$

If all the variables entering equations (10) and (11) were known with certainty, then (10) and (11) would be definitional identities. Given that transportation costs are difficult to determine with accuracy, while one can postulate variables that are likely to affect it, the price linkages above can be rewritten as:

$$(12) \qquad P_j = P_i^o + f_{ij}(Z) \qquad \text{for } X_{ij} > 0$$

or:

$$(13) \qquad P_j = P_i^o - f_{ji}(Z) \qquad \text{for } X_{ji} > 0$$

where $P_i^o = P_i E_{ij} + T_j$ if region i is importing, $P_i^o = (P_i - T_i) E_{ij}$ if region i is exporting, and Z is the vector of variables which define transfer costs. Given a specification for f(Z), both equation (12) and (13) could be estimated. It should be noted that each one is well defined only for a given direction of trade. Under certain restrictive assumptions, they could be merged in a single equation with "if" statements switching the sign of price differences. Alternatively, one can choose a sample period for which the trade flows do not change sign, and this is the approach that is followed in the econometric application. The transfer function f(Z) is specified as a linear function, that is:

$$f(Z) = \Sigma_k \alpha_k Z_k + \varepsilon \tag{14}$$

where the α's are parameters to be estimated, and ε is a residual random term. Concerning the choice of the Z variables, an obvious indicator of transportation costs would be any of the variables reported in Table 8. The personal transportation component of the CPI in Canada is used here, since preliminary analysis showed that this indicator gave results comparable to the other ones, and it is available for a longer time period. However, this approach does imply that the transportation cost between two regions is constant at any point in time. An alternative assumption is that, given a short term rigidity in the supply of transportation services, the transportation cost will increase with the quantity traded, which is therefore a natural choice for one of the Z variables. To account for seasonal effects, seasonal dummies are also included in the vector Z. Substituting (14) into (12) or (13) gives an equation which allows the estimation of the α coefficients of the transfer function. However, to leave some scope for the testing of the spatial equilibrium model, it is desirable to estimate the more general model:

$$P_{jt} = \beta \left(P^o_{it} + \Sigma_k \alpha_k Z_{kt} \right) + \varepsilon_{jt} \tag{15}$$

which for β = 1 will be fully consistent with the spatial equilibrium model.

Equation (15) was estimated for each of the price linkages of interest. In all cases, the dependent price is the Canadian price when the right-hand-side price is the US price, and the Toronto price for East-West price linkages. The US price embodies the relevant custom duty and the effects of the exchange rate. The price linkage equation was estimated both with and without the net trade variable, and with and without the restriction $\beta = 1$. The net trade variable, when used, is expressed as Eastern Canada net exports to the US, and Western Canada net exports to the US and to Eastern Canada.

The estimation results of this stage are reported in Tables 12 to 22. Both ordinary least squares and generalized least squares, assuming first order serial correlation of the residuals, are reported (GLS estimates are readily recognized for reporting a value for rho, the autocorrelation coefficient). In addition to the usual statistics of interest, for each equation a test of seasonality and a test of heteroscedasticity was performed. The seasonality test is an F-test of the hypothesis that the coefficients of the three seasonal dummies are jointly zero. The heteroscedasticity test is a version of the Breusch-Pagan test (Judge et al., 1985, pp. 446-447). It is defined as TR^2, where T is the sample size, and R^2 is the square of the multiple regression coefficient of the regression of the squared estimated residuals on a constant and on the right-hand-side price variable. This test is asymptotically distributed as a χ^2 with 1 degree of freedom. The relevance of this test is in the hypothesis that the variance of price spreads may increase as the nominal prices increase. Finally, the period over which each price linkage equation is estimated is selected so as to give the most recent period after 1975 for which the relevant trade flow is uniformly in one direction. Following the discussion in section 2.2, it should be clear that the trade flow of interest is the one for the commodity whose prices are spatially related, and that aggregation with related outputs is not warranted.

Table 10 reports twelve equations pertaining to the Eastern Canada - US price linkage for slaughter steers. All the equations are estimated for the period 1978 2 to 1986 3, during which Eastern Canada was always a net importer. While the goodness of fit of the unconstrained equations is reasonably high, as illustrated by the corresponding R^2's ranging from 0.92 to 0.96, the goodness of fit of the constrained equations, which displays the ability of the remaining variables to explain price differences, is acceptable only for the equations with the net trade variable. In all cases transportation costs do not seem to be relevant, while the net trade variable is very significant when used. The coefficient of the price variable is not significantly different from one when the net trade variable is used. In the OLS estimates, the Durbin-Watson statistics do not indicate the presence of serial correlation, and in fact the GLS estimates display low values for the autocorrelation coefficient. For all the equations, there is no indication of seasonal effects or heteroscedasticity.

Table 11 reports the estimated price linkage equations for slaughter cows between Eastern Canada and the US. The estimation period is 1977 1 to 1986 3, during which Eastern Canada was a net exporter of slaughter cows to the US. The fit is very good for the unconstrained equations (R^2 of 0.99 for all of them), while it is very low when the price coefficient is constrained to one. The price coefficient is always

Table 10 - Price linkage equations estimation: slaughter steers and heifers between Eastern Canada and U.S.
dependent variable pss2

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	11.6858	0.3260	-0.6464	-0.8170	0.0187	0.8403			0.92	1.66	0.003	0.827
	3.8172	0.8702	0.8532	0.8365	0.0153	0.0548					0.956	0.490
b	1.5159	-0.0679	-1.1551	-0.9643	-0.0019	1.0000			0.08	1.81	0.152	0.815
	1.7337	0.9643	0.9368	0.9366	0.0152						0.696	0.496
c	4.9798	0.2220	-0.8082	-0.6726	0.0077	0.9241	-0.1513		0.96	1.84	1.444	1.250
	3.2362	0.6608	0.6485	0.6356	0.0119	0.0453	0.0325				0.230	0.311
d	-0.0486	0.0495	-1.0348	-0.7109	-0.0022	1.0000	-0.1730		0.57	1.79	0.946	1.341
	1.2418	0.6734	0.6542	0.6553	0.0106		0.0308				0.331	0.281
e	12.4916	0.3274	-0.6021	-0.8049	0.0210	0.8269		0.17	0.93	1.92	0.016	0.795
	3.9815	0.7920	0.8334	0.7661	0.0176	0.0566					0.899	0.507
f	1.5511	-0.0618	-1.1564	-0.9649	-0.0022	1.0000		0.09	0.09	1.95	0.225	0.802
	1.8728	0.9166	0.9289	0.8933	0.0166						0.635	0.503
g	5.0618	0.2238	-0.8087	-0.6740	0.0078	0.9227	-0.1543	0.08	0.96	1.97	1.252	1.225
	3.3429	0.6325	0.6455	0.6101	0.0127	0.0467	0.0337				0.263	0.321
h	-0.0473	0.0607	-1.0413	-0.7125	-0.0025	1.0000	-0.1783	0.10	0.57	1.94	0.827	1.341
	1.3417	0.6393	0.6486	0.6244	0.0116		0.0318				0.363	0.282

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pss4*er34+tarsct34) ; netexp = (ne2ss4+ne2hf4)
Bounds: 1978 2 to 1986 3 .

Table 11 - Price linkage equations estimation: slaughter bulls and cows between Eastern Canada and U.S. dependent variable pbw2

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	0.5997	0.4585	-0.9370	0.5567	-0.0112	1.0748			0.99	1.65	0.088	2.985
	1.1752	0.5719	0.5826	0.5745	0.0091	0.0254					0.767	0.045
b	2.7594	0.5972	-0.5802	0.7729	0.0005	1.0000			0.15	1.25	1.237	2.000
	1.0163	0.6309	0.6308	0.6308	0.0090						0.266	0.132
c	0.7755	0.3979	-0.9530	0.4207	-0.0110	1.0787	-0.0217		0.99	1.66	0.163	2.440
	1.2169	0.5847	0.5883	0.6170	0.0092	0.0263	0.0337				0.687	0.082
d	2.7407	0.6006	-0.5804	0.7810	0.0004	1.0000	0.0014		0.15	1.26	1.223	1.767
	1.1400	0.6467	0.6403	0.6738	0.0093		0.0365				0.269	0.173
e	0.7480	0.4687	-0.9123	0.5736	-0.0107	1.0702		0.18	0.99	2.06	0.114	3.319
	1.3339	0.5222	0.5723	0.5263	0.0108	0.0293					0.735	0.032
f	2.6522	0.6469	-0.5309	0.8140	0.0010	1.0000		0.37	0.26	2.19	0.039	3.464
	1.3664	0.4979	0.5510	0.4978	0.0129						0.844	0.027
g	0.9047	0.4124	-0.9253	0.4420	-0.0106	1.0745	-0.0215	0.17	0.99	2.06	0.170	2.696
	1.3688	0.5377	0.5788	0.5788	0.0108	0.0302	0.0371				0.680	0.063
h	2.7067	0.6386	-0.5277	0.7910	0.0011	1.0000	-0.0044	0.37	0.27	2.19	0.041	2.786
	1.4857	0.5116	0.5597	0.5517	0.0132		0.0426				0.839	0.057

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pbw4-tar4sct3)*er34 ; netexp = nt2bw4 .
Bounds: 1977 1 to 1986 3 .

significantly greater than one, which was to be expected given the type of inconsistency reported in Table 9. Neither the transportation cost variable nor the net trade variable display any significant impact. Some serial correlation seems to be present in the equations with the constrained price coefficient, while there is no indication of heteroscedasticity. The hypothesis of no seasonal effects can be rejected for equatons a and f at the 5% probability level.

Table 12 reports price linkage equations between Eastern Canada and the US for hogs. Eastern Canada has always been a net exporter of hogs to the United States due to health regulations inhibiting imports of live hogs, but only since 1982 have these exports reached a sizable level (Table 4). Thus, the estimation period is chosen to be be 1982 1 to 1986 3. In all estimates the transportation variable has the correct sign, but it is significant only in the OLS equations without the net trade variable. The coefficient of the net trade variable is always significant, and the attached negative sign indicates higher price spreads associated with larger volumes of trade. Although always below one, the coefficient of the price variable is not significantly different from one at the 5 percent probability level. The R^2 is good for both the unconstrained and the constrained equations, especially when the net trade variable is used. The DW statistics suggest the presence of autocorrelation in the estimated residuals, although the problem appears less serious for the equations containing the net trade variable. The BP test gives no indication of heteroscedasticity, and the hypothesis of no seasonal effects cannot be rejected in any of the estimated equations.

Table 12 - Price linkage equations estimation: hogs between Eastern Canada and U.S. dependent variable phg2

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	18.7246	-1.5068	-0.7339	0.2319	-0.1688	0.9457			0.96	0.91	1.483	0.460
	13.4425	1.6522	1.6552	1.7664	0.0907	0.0665					0.223	0.715
b	12.3838	-1.5470	-0.7921	-0.2939	-0.1519	1.0000			0.21	0.98	1.310	0.360
	10.8376	1.6316	1.6339	1.6249	0.0872						0.252	0.783
c	5.9756	-0.3217	0.1208	0.0889	-0.0333	0.9226	-0.1997		0.99	1.34	1.244	0.088
	8.4754	1.0205	1.0085	1.0605	0.0610	0.0402	0.0407				0.265	0.965
d	-2.3559	-0.4326	-0.0003	-0.6441	-0.0158	1.0000	-0.1906		0.67	1.25	0.004	0.187
	8.0108	1.1200	1.1065	1.0880	0.0663		0.0444				0.950	0.903
e	16.6697	-1.3545	-0.5636	0.5555	-0.1358	0.9191		0.57	0.97	2.02	1.205	0.812
	16.9776	1.0717	1.2039	1.1776	0.1340	0.0626					0.272	0.512
f	11.5385	-1.4059	-0.6097	-0.1010	-0.1468	1.0000		0.52	0.42	1.89	1.413	0.558
	15.6861	1.1226	1.2561	1.1188	0.1275						0.234	0.652
g	4.3985	-0.1450	0.3127	0.2610	-0.0206	0.9208	-0.2012	0.33	0.99	1.97	0.493	0.119
	9.9330	0.8742	0.9265	0.8945	0.0761	0.0417	0.0475				0.483	0.947
h	-2.9398	-0.1859	0.2801	-0.3887	-0.0128	1.0000	-0.1971	0.38	0.71	1.86	0.353	0.252
	10.5636	0.9415	1.0015	0.8780	0.0874		0.0534				0.553	0.859

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (phg4/0.77-tar4hg3)*er34 ; netexp = ne2hg4 .
Bounds: 1982 1 to 1986 3 .

Table 13 reports the estimated equations for the price linkage of slaughter lambs between Eastern Canada and US. Eastern Canada has always been in a net importing situation, and the estimation period is 1976 1 to 1986 3. The goodnes of fit is reasonably high for the unconstrained equations, and satisfactory when the constraint $\beta = 1$ is imposed. The transportation cost variable is sgnificant in all equations (except equation h), and with the correct sign. The coefficient of the price variable is not different from one only when the net trade variable is omitted, and similarly the net trade variable has a significant impact only when the price coefficient is not constrained to one. The DW statistics do not suggest the presence of any serious serial correlation in the residuals. There is a strong seasonal effect in the price spread, and heteroscedasiticity is present in all unconstrained equations, but not in the constrained ones.

Table 14 reports the estimation results for the price linkage equations of slaughter steers and bulls between Western Canada and the US. The estimation period is 1981 3 to 1986 3, for which Western Canada has been a net exporter. The goodness of fit is not too high for the unrestricted equations, the R^2 ranging from 0.87 to 0.90, although it is satisfactory for the restricted equations with the net trade variable. The net trade variable is always significant, and the negative sign indicates higher price spreads associated with larger volumes of trade. The transportation variable does not have a significant impact, and the coefficient of the US price is in all cases significantly less than one. The DW test does not indicate the presence of autocorrelation in the residuals, especially for the equations with the net trade variable. The Breush-Pagan test shows that heteroscedasticity is not a problem, and

Table 13 - Price linkage equations estimation: slaughter lambs between Eastern Canada and U.S. dependent variable pslm2

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	0.7266	6.3827	5.9713	-0.1831	0.0722	0.9367			0.93	1.75	4.666	6.377
	4.0326	2.0099	2.0979	2.0003	0.0347	0.0671					0.031	0.001
b	-1.8418	6.1602	5.3613	-0.3112	0.0516	1.0000			0.36	1.83	2.891	6.100
	2.9694	1.9931	1.9928	1.9928	0.0269						0.089	0.002
c	13.9261	6.1398	8.6814	-0.3992	0.0939	0.7869	0.5652		0.93	1.51	5.866	8.207
	7.6812	1.9378	2.4346	1.9277	0.0351	0.0992	0.2839				0.015	0.000
d	-0.5517	6.0208	5.5908	-0.4052	0.0467	1.0000	0.1024		0.37	1.79	2.432	6.073
	3.8664	2.0295	2.0583	2.0198	0.0287		0.1937				0.119	0.002
e	1.7278	6.4713	6.2198	-0.1448	0.0820	0.9097		0.15	0.93	1.95	3.977	6.462
	4.4958	1.8699	2.0863	1.8567	0.0397	0.0752					0.046	0.001
f	-1.8745	6.1566	5.3567	-0.3169	0.0520	1.0000		0.08	0.37	1.96	2.410	6.006
	3.1559	1.9119	1.9792	1.9115	0.0291						0.121	0.002
g	17.7610	6.2740	9.6058	-0.3796	0.1158	0.7160	0.6713	0.29	0.94	1.86	5.626	9.319
	7.3944	1.6595	2.2597	1.6403	0.0440	0.0991	0.2597				0.018	0.000
h	-0.0811	5.9634	5.6801	-0.4475	0.0453	1.0000	0.1435	0.11	0.37	1.95	1.853	6.052
	4.1649	1.9202	2.0417	1.9089	0.0318		0.2058				0.173	0.002

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pslm4*er34+tar3lmb4) ; netexp = exsh2-imsh2;
Bounds: 1976 1 to 1986 3 .

Table 14 - Price linkage equations estimation: slaughter steers and heifers between Western Canada and U.S. dependent variable pss1

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	18.9418	-2.7067	0.4181	-1.1442	-0.0276	0.7340			0.87	1.71	0.714	3.289
	7.8795	1.1148	1.1504	1.0506	0.0468	0.0829					0.398	0.050
b	1.1593	-3.3940	-0.7309	-1.4963	-0.0512	1.0000			0.33	1.34	0.052	2.259
	7.0381	1.3753	1.3743	1.3135	0.0581						0.819	0.121
c	9.6414	-1.8984	0.9488	-0.3579	0.0236	0.7827	-0.1179		0.90	2.04	0.018	2.659
	8.6813	1.1057	1.0918	1.0468	0.0504	0.0802	0.0607				0.894	0.089
d	-7.5232	-2.0523	0.3333	-0.2744	0.0285	1.0000	-0.1694		0.52	1.87	0.005	1.518
	7.0770	1.3170	1.2736	1.2480	0.0601		0.0688				0.943	0.251
e	17.1399	-2.7970	0.2950	-1.2079	-0.0277	0.7580		0.17	0.87	1.84	1.104	2.691
	8.4342	1.0195	1.1226	0.9673	0.0533	0.0818					0.293	0.086
f	0.5749	-3.4281	-0.7842	-1.5225	-0.0461	1.0000		0.33	0.40	1.77	0.385	2.962
	9.0305	1.1130	1.2322	1.0835	0.0745						0.535	0.066
g	9.7117	-1.8409	1.0007	-0.3100	0.0253	0.7794	-0.1221	-0.06	0.90	1.98	0.006	2.030
	8.5504	1.1290	1.0872	1.0676	0.0486	0.0802	0.0602				0.938	0.159
h	-7.1189	-2.1519	0.2443	-0.3641	0.0248	1.0000	-0.1586	0.08	0.52	1.95	0.006	1.385
	7.4559	1.2751	1.2673	1.2115	0.0632		0.0696				0.940	0.288

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pss4-tar4sct3)*er34 ; netexp = ne1ss4+ne1hf4 .
Bounds: 1981 3 to 1986 3 .

the hypothesis of no seasonal effects is not rejected in any equation.

Table 15 contains the estimated parameters of the price linkage equations of slaughter bulls and cows between Western Canada and the US The period since 1976, for which Western Canada has been a consistent net exporter to the US, has been used for estimation. The equations estimated give very satisfactory results. The transportation cost variable is always very significant and with the correct negative sign, the price coefficient is not different from one, there is no serious indication of serial correlation of the residuals, and the goodness of fit is very high (0.99 for the unconstrained equations, and ranging from 0.45 to 0.55 for the constrained ones). When included the net trade variable shows a significant effect, with the implication that higher volumes of trade are associated with larger price spreads. Homoscedasticity is rejected only for equation a, while a significant seasonal effect is present only in the equations without the net trade variable.

The estimated price linkage equations for the price of feeder calves between Western Canada and the US is reported in Table 16. The estimation period is 1976 1 to 1986 3, for which Western Canada has consistently been a net exporter. The fit of the equations is reasonably good for both restricted and unrestricted equations, especially in the GLS estimation. The transportation variable has the correct negative sign, and displays a significant impact mostly in the OLS estimates. There is indication of serial correlation in the residuals, heteroscedasticity and strong seasonality in the price spread. The coefficient of the US price is lower than one, but the hypothesis of it being one cannot be rejected for any equation at the 5%

Table 15 - Price linkage equations estimation: slaughter bulls and cows between Western Canada and U.S. dependent variable pbw1

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	1.1972	1.2666	1.4342	1.8126	-0.0454	1.0393			0.99	1.69	4.020	3.444
	0.9788	0.5891	0.5994	0.5905	0.0098	0.0236					0.045	0.026
b	1.9341	1.3608	1.6420	1.9301	-0.0359	1.0000			0.45	1.57	2.391	3.984
	0.8940	0.6001	0.6000	0.6000	0.0081						0.122	0.015
c	4.7998	0.7373	0.5947	0.9973	-0.0492	1.0037	-0.0388		0.99	2.02	2.389	0.815
	1.8797	0.6097	0.6856	0.6725	0.0094	0.0276	0.0176				0.122	0.494
d	4.9745	0.7243	0.5776	0.9755	-0.0487	1.0000	-0.0401		0.55	2.03	2.207	0.848
	1.3444	0.5940	0.6649	0.6441	0.0087		0.0141				0.137	0.477
e	1.1919	1.2553	1.4227	1.7981	-0.0449	1.0386		0.15	0.99	1.98	3.473	3.626
	1.0914	0.5475	0.5926	0.5495	0.0112	0.0268					0.062	0.022
f	1.8790	1.3537	1.6302	1.9144	-0.0352	1.0000		0.21	0.48	2.00	2.223	4.438
	1.0465	0.5348	0.5749	0.5347	0.0099						0.136	0.009
g	4.9041	0.7245	0.5728	0.9763	-0.0493	1.0028	-0.0399	-0.03	0.99	1.97	2.389	0.668
	1.8643	0.6152	0.6837	0.6768	0.0092	0.0272	0.0175				0.122	0.578
h	5.0463	0.7127	0.5562	0.9567	-0.0490	1.0000	-0.0411	-0.03	0.55	1.97	2.256	0.720
	1.3215	0.5999	0.6614	0.6482	0.0085		0.0139				0.133	0.546

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pbw4-tar4sct3)*er34 ; netexp = nt1bw4 .
Bounds: 1976 1 to 1986 3 .

Table 16 - Price linkage equations estimation: feeder calves between Western Canada and U.S. dependent variable pfc1

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	5.6297	-4.0916	-5.8226	-3.6877	-0.0282	0.9690			0.97	1.00	5.561	3.889
	2.8399	1.7399	1.7453	1.7383	0.0275	0.0327					0.018	0.016
b	4.5230	-4.1774	-5.9811	-3.7423	-0.0419	1.0000			0.29	0.98	5.908	4.139
	2.5853	1.7353	1.7350	1.7350	0.0234						0.015	0.012
c	12.6384	-6.4181	-7.2888	-6.1277	-0.0415	0.9389	-0.1455		0.97	1.19	3.686	6.589
	3.7469	1.8413	1.7134	1.8610	0.0261	0.0324	0.0553				0.055	0.001
d	8.9604	-5.9795	-7.1927	-5.6067	-0.0618	1.0000	-0.1088		0.36	1.04	5.378	5.822
	3.3059	1.8883	1.7706	1.9026	0.0246		0.0535				0.020	0.002
e	5.5539	-4.3437	-6.1650	-4.0702	-0.0233	0.9697		0.51	0.98	1.87	4.990	6.441
	4.3532	1.2282	1.3970	1.2174	0.0463	0.0509					0.025	0.001
f	4.5939	-4.4665	-6.3548	-4.1494	-0.0374	1.0000		0.52	0.46	1.88	5.302	7.138
	4.0823	1.1949	1.3442	1.1946	0.0401						0.021	0.001
g	9.9436	-5.8532	-7.0966	-5.6526	-0.0325	0.9524	-0.0981	0.45	0.98	1.93	3.989	7.824
	4.5214	1.4766	1.4762	1.4999	0.0410	0.0466	0.0532				0.046	0.000
h	7.8610	-5.8370	-7.2646	-5.5760	-0.0516	1.0000	-0.0851	0.49	0.50	1.96	4.765	8.153
	4.3284	1.4508	1.4419	1.4736	0.0386		0.0520				0.029	0.000

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (pfc4-tar4fct3)*er34 ; netexp = (nt1fct4+nt1fcv4) .
Bounds: 1976 1 to 1986 3 .

probability level.

Table 17 reports the estimated price linkage equations for hog prices between Western Canada and the US. These equations are estimated over the period 1980 1 to 1986 3, during which net exports are sizable. The goodnes of fit is reasonably high for both constrained and unconstrained equations. The trade variable has a significant effect, with a higher price spread associated with larger volumes of trade. The transportation cost variable is also always significant, and with the correct sign. The coefficient of the price variable is not significantly different from one. Serial correlation seems to be a problem only for the equations without the net trade variable, which suggests that omitting this variable introduces functional misspecification. The hypothesis of homoscedasticity is never rejected, and there is no indication of seasonal effects on price spreads.

The price linkage between Western and Eastern Canada for slaughter steers and heifers gives the best results of the estimated equations, and these are reported in Table 18. The estimation period is 1976 1 to 1986 3, and the trade flow for this period is consistently from west to east. Given that the dependent variable in these equations is the Toronto price, the positive sign of the transportation variable is the expected one, and its estimated coeffient is always significant. The coefficients on the Western price are not different from one, and there is no sizable serial correlation in the residuals. Again, the trade variable when used is very significant, and given that net trade is now defined as Western net exports to Estern Canada, its positive sign means that higher exports are associated with larger price spreads, a pattern observed in all other price linkage equations. The goodness of fit is

Table 17 - Price linkage equations estimation: hogs between Western Canada and U.S. dependent variable phg1

eq	const	js1	js2	js3	cpipt3	US price	netexp	rho	R2	DW	BP	seas
a	20.0131	-2.8874	-3.3625	-2.2638	-0.1714	0.9258			0.91	0.94	0.001	1.093
	5.5671	1.9874	1.9859	2.1065	0.0562	0.0771					0.976	0.374
b	18.2776	-2.8893	-3.3257	-2.9466	-0.2049	1.0000			0.53	1.05	0.057	1.164
	5.2573	1.9840	1.9821	1.9798	0.0440						0.811	0.346
c	12.9851	-1.9860	-3.3664	-2.2407	-0.0884	0.9389	-0.3066		0.96	1.97	0.127	1.891
	4.2946	1.4436	1.4288	1.5156	0.0444	0.0556	0.0676				0.721	0.164
d	11.4714	-1.9763	-3.3363	-2.8012	-0.1149	1.0000	-0.3105		0.76	2.02	0.144	2.041
	4.0878	1.4507	1.4355	1.4342	0.0375		0.0679				0.704	0.139
e	19.1463	-2.7574	-3.3108	-1.3834	-0.1039	0.8336		0.61	0.94	2.20	0.059	2.018
	9.0403	1.2424	1.3998	1.3889	0.0876	0.0769					0.809	0.144
f	17.2762	-2.7403	-3.1471	-2.7697	-0.1979	1.0000		0.48	0.63	1.96	0.360	1.739
	7.7096	1.4161	1.5787	1.4136	0.0667						0.549	0.190
g	12.9907	-1.9858	-3.3659	-2.2389	-0.0884	0.9388	-0.3065	0.00	0.96	1.98	0.128	1.790
	4.3003	1.4425	1.4288	1.5146	0.0444	0.0556	0.0677				0.721	0.183
h	11.4196	-1.9871	-3.3546	-2.8183	-0.1140	1.0000	-0.3132	-0.04	0.76	1.96	0.113	1.956
	3.9585	1.4766	1.4333	1.4613	0.0362		0.0657				0.736	0.153

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
US price = (phg4/0.77-tar4hg3)*er34 ; netexp = ne1hg4 .
Bounds: 1980 1 to 1986 3 .

Table 18 - Price linkage equations estimation: slaughter steers and heifers between Western and Eastern Canada dependent variable pss2

eq	const	js1	js2	js3	cpipt3	WC price	netexp	rho	R2	DW	BP	seas
a	-1.5551	1.8603	-0.1449	0.3106	0.0861	0.9815			0.99	1.56	2.305	5.013
	1.0786	0.5910	0.5920	0.5900	0.0108	0.0200					0.129	0.005
b	-2.1320	1.8924	-0.1906	0.3207	0.0794	1.0000			0.75	1.57	2.118	5.397
	0.8773	0.5889	0.5888	0.5888	0.0079						0.146	0.003
c	-3.3637	1.2292	-0.3721	-0.4300	0.0815	1.0070	0.1079		1.00	1.71	0.392	4.591
	1.0756	0.5477	0.5221	0.5579	0.0095	0.0190	0.0308				0.531	0.008
d	-3.1050	1.2442	-0.3483	-0.4035	0.0839	1.0000	0.1036		0.82	1.68	0.499	4.664
	0.8048	0.5397	0.5120	0.5467	0.0070		0.0281				0.480	0.007
e	-1.4000	1.8812	-0.0980	0.3383	0.0881	0.9758		0.22	0.99	1.89	2.374	5.720
	1.2746	0.5219	0.5658	0.5207	0.0132	0.0240					0.123	0.003
f	-2.1397	1.9144	-0.1665	0.3438	0.0792	1.0000		0.21	0.76	1.90	2.278	6.053
	1.0281	0.5240	0.5636	0.5239	0.0097						0.131	0.002
g	-3.3031	1.2804	-0.3309	-0.3748	0.0822	1.0049	0.1038	0.11	1.00	1.91	0.342	4.653
	1.1596	0.5196	0.5162	0.5306	0.0106	0.0207	0.0311				0.559	0.008
h	-3.1279	1.2923	-0.3121	-0.3552	0.0839	1.0000	0.1010	0.12	0.82	1.91	0.396	4.769
	0.8769	0.5098	0.5043	0.5174	0.0078		0.0285				0.529	0.007

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
WC price = pss1 ; netexp = ex1ss2+ex1hf2 .
Bounds: 1976 1 to 1986 3 .

very good (although the 1.00 reported in the Table 18 really results from rounding), with the R^2 of the restricted models being as high as 0.82. The hypoyhesis of homoscedasticity is never rejected, but the seasonality test shows a seasonal patterns in this price spread.

The price linkage equations for feeder calves between Western and Eastern Canada are reported in Table 19. The estimating period is again 1976 1 to 1986 3, and the direction of trade is consistently from Western to Eastern Canada. The estimated equations fit the data well, with an R^2 of 0.99 for the unrestricted models, and as high as 0.67 for the restricted ones. The coefficient of the price variable is significantly different from one in all cases. For this reason, the restricted versions of the equations are not very meaningful, and are characterized by poor fit (in the OLS estimation), insignificant transportation cost parameters, and serial correlation in the residuals. When this type of misspecification is avoided, the transportation cost variable is very significant, while the net trade variable is not. Heteroscedasticity only appears in the restricted GLS equations, while all the equations display a strong seasonal pattern.

Finally, Table 20 reports the estimated equations between Western and Eastern Canada hog prices for the period 1979 2 to 1985 4, for which the trade flow has been consistently from west to east. The fit of the estimated equations is good for the unrestricted model, while it leaves something to be desired when the coefficient of the price variable is constrained to one. Although the coefficient of the price variable is always less than one, the hypothesis of it being equal to one cannot be rejected at the 5% probability level. Both the transportation variable and the net trade variable have only a moderately significant impact,

Table 19 - Price linkage equations estimation: feeder calves between Western and Eastern Canada dependent variable pfc2

eq	const	js1	js2	js3	cpipt3	WC price	netexp	rho	R2	DW	BP	seas
a	1.1579	1.3199	3.9705	1.5466	0.1368	0.7815			0.99	2.02	2.427	10.045
	1.2462	0.7443	0.7440	0.7444	0.0115	0.0142					0.119	0.000
b	-7.6333	1.6279	4.1596	1.9792	0.0494	1.0000			0.17	0.45	1.352	1.473
	2.9836	2.0027	2.0023	2.0023	0.0270						0.245	0.237
c	-0.6477	2.7520	5.6545	3.5280	0.1376	0.7732	0.0088		0.99	2.08	2.311	7.770
	1.9769	1.4282	1.6156	1.8448	0.0115	0.0158	0.0075				0.128	0.000
d	1.9973	-4.8729	-3.4553	-7.0165	0.0608	1.0000	-0.0398		0.27	0.75	2.833	1.451
	5.0465	3.4005	3.8111	4.3411	0.0261		0.0173				0.092	0.244
e	1.1322	1.3136	3.9644	1.5406	0.1369	0.7818		-0.05	0.99	1.94	2.478	9.739
	1.2049	0.7604	0.7425	0.7605	0.0110	0.0136					0.115	0.000
f	-4.5531	1.3453	4.0496	2.0728	0.0195	1.0000		0.77	0.66	2.17	4.470	5.526
	6.4255	0.8859	1.0077	0.8859	0.0639						0.034	0.003
g	-0.7543	2.7959	5.7083	3.5931	0.1378	0.7733	0.0092	-0.08	0.99	1.95	2.416	7.241
	1.9150	1.4256	1.5933	1.8306	0.0107	0.0149	0.0074				0.120	0.001
h	-5.2828	1.9107	4.7177	2.8686	0.0174	1.0000	0.0035	0.78	0.67	2.17	4.338	3.929
	7.1200	2.0346	2.3817	2.7112	0.0662		0.0114				0.037	0.016

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
WC price = pfc1 ; netexp = (ex1fct2+ex1fcv2) .
Bounds: 1976 1 to 1986 3 .

Table 20 - Price linkage equations estimation: hogs between Western and Eastern Canada
dependent variable phg2

eq	const	js1	js2	js3	cpipt3	WC price	netexp	rho	R2	DW	BP	seas
a	0.8827	0.1823	0.8287	0.6748	0.0386	0.9527			0.98	1.14	2.561	0.375
	2.6143	0.9340	0.9018	0.9111	0.0197	0.0377					0.110	0.772
b	-1.1569	0.2632	0.9156	0.4694	0.0278	1.0000			0.13	1.07	2.446	0.358
	2.0740	0.9439	0.9108	0.9079	0.0180						0.118	0.784
c	0.0179	0.0917	0.7659	0.7061	0.0483	0.9418	0.2028		0.98	1.15	0.142	0.424
	2.5333	0.8899	0.8585	0.8668	0.0195	0.0364	0.1132				0.706	0.738
d	-2.2931	0.2022	0.8793	0.4556	0.0339	1.0000	0.1723		0.21	0.99	0.002	0.361
	2.1582	0.9197	0.8869	0.8838	0.0180		0.1157				0.965	0.782
e	0.3526	0.0907	0.8700	0.6739	0.0394	0.9586		0.42	0.98	2.08	7.439	0.586
	3.5111	0.7062	0.7681	0.6940	0.0274	0.0438					0.006	0.631
f	-1.5747	0.1587	0.9639	0.5038	0.0311	1.0000		0.45	0.31	2.14	7.387	0.617
	2.9842	0.6910	0.7532	0.6588	0.0268						0.007	0.611
g	-1.3065	0.0691	0.8173	0.6075	0.0442	0.9664	0.2273	0.46	0.98	2.12	2.668	0.591
	3.5754	0.6540	0.7165	0.6444	0.0274	0.0422	0.1199				0.102	0.628
h	-2.9794	0.1219	0.8905	0.4681	0.0381	1.0000	0.2441	0.53	0.42	2.20	2.650	0.648
	3.2110	0.6231	0.6872	0.5941	0.0285		0.1189				0.104	0.593

Note: For each variable the first row reports coefficient estimates, and the second row the standard errors.
For the Breusch-Pagan test, the first row reports the chi-2 test, and the second row the significance level.
For the seasonality test, the first row reports the F-test, and the second row the significance level.
WC price = phg1 ; netexp = ne1hg2q .
Bounds: 1979 2 to 1985 4 .

and serial correlation of the residuals is present in all the equations. There is no indication of heteroscedasticity (except in the GLS equations without the trade variable), and no apparent seasonal component in the price spread.

3.4. Summary of econometric results

Some generalizations appear justified based on the foregoing analysis. First, the predictive power of the estimated equation is in general satisfactory, as the R^2 of unrestricted equation is always above 0.90. Second, the predictive ability of price differences (models with the price coefficients restricted to one) is very different from case to case. In some case this may be due to the fact that the restriction of unity on the price coefficent is not acceptable based on the estimation results. Also, it should be kept in mind that the R^2 of the restricted equations measures the explanatory power of variables other than the right-hand-side price. If this price explains a lot, a low R^2 of the unrestricted equation does not necessarily imply poor predictive ability for the model. Third, seasonality does not appear to have a significant influence on the estimated price relationships, except for the case of lambs and feeder calves. Heteroscedasticity is not a problem, and serial correlation reaches serious levels in only a few cases. Finally, in virtually all cases the size of price spreads is significantly related to the volume of trade flows. While this can be explained by an upward sloping supply of transportation services, the endogeneity of the net trade variable within a larger model may suggest some simultaneous equation bias in our estimates. It should be pointed out, however, that the implementation of a correct estimation procedure under this assumption, such as 2SLS or IV, is problematic without the specification of a full model, and that the loss of efficiency of these estimators may hinder the predictive accuracy of the equations.

Based on the above, Table 21 offers some summary results for the OLS estimates of the unrestricted equations with the trade variable. The predictive accuracy of the model can be evaluated from the squared multiple correlation coeffient (R^2), and from the mean absolute error (mae), which is evaluated for the whole estimation period for each equation, and for the quarters starting from 1984 1. In each case, the mean of the left-hand-side price (in Canadian dollars) is reported for comparison. The best predictive ability is displayed by the slaughter steer and slaughter cow equations, whereas larger predictive errors are associated with the feeder calf and slaughter lamb equations. The size of the error seems to be greater in the last period, although the Breusch-Pagan test, performed assuming that the error variance can be explained by time (and reported in the last column of Table 21), does not indicate significant heteroscedasticity. The predictive accuracy of these equations is also illustrated by the plots of observed and fitted price spreads reported in Appendix C. Whether errors of this size are tolerable in empirical applications is an open question. Obtaining better results may be a difficult task, however, given the care that was taken in specifying the models and choosing an appropriate estimation period.

Concerning the reliability of the above estimates, some light may be shed by the Chow tests reported in Table 21. These are structural change tests which are performed by breaking the sample in the middle, and testing whether the coefficient vector (or subsets of it) is significantly different between the two subperiods. This leads to a

Table 21 - Predictive accuracy of unrestricted OLS estimates

			forecasting accuracy				chow tests			BPt
		R2	mp	mae	mp	mae	(c)	(d)	(e)	(f)
			(a)		(b)		significance level			
Slaughter steers	EC-US	0.96	79.66	0.87	82.91	1.19	0.350	0.561	0.679	0.124
	WC-US	0.90	73.19	0.98	74.13	1.10	0.537	0.896	0.608	0.767
	EC-WC	1.00	72.24	0.88	82.91	1.38	0.091	0.033	0.018	0.084
Slaughter cows	EC-US	0.99	49.89	0.95	52.89	0.87	0.007	0.118	0.111	0.593
	WC-US	0.99	44.45	0.92	48.83	1.18	0.086	0.219	0.141	0.480
Feeder calves	WC-US	0.97	77.61	2.58	87.60	3.51	0.041	0.006	0.195	0.167
	EC-WC	0.99	76.71	1.23	88.69	1.11	0.997	0.990	0.944	0.809
Hogs	EC-US	0.99	74.94	0.97	73.09	0.98	0.050	0.084	0.197	0.073
	WC-US	0.96	69.52	1.72	69.57	1.72	0.097	0.015	0.021	0.612
	EC-WC	0.98	70.11	1.12	70.68	1.36	0.146	0.070	0.031	0.240
Slaughter lambs	EC-US	0.93	81.64	3.20	98.76	4.59	0.128	0.343	0.600	0.151

Note: mp - mean of left-hand-side price;
mae - mean absolute error;
(a) - whole estimation period;
(b) - period 1984 1 to 1986 3 (1984 1 to 1985 4 for EC-WC hogs);
(c) - the Chow test applies to all seven coefficients;
(d) - the Chow test applies to the coefficents of transportation, price, and trade variables;
(e) - the Chow test applies to the coefficents of price and trade variables;
(f) - Breusch-Pagan test postulating variance as function of time.

test based on the F-distribution (Johnston, 1984, p. 508) which can prove useful for testing the stability of econometric estimates (Moschini and Meilke, 1984). The significance levels reported in Table 21 suggest that stability problems exist for the coefficients in the price linkage equations for: slaughter steers between Eastern and Western Canada; slaughter cows between Eastern Canada and the US, feeder calves between Western Canada and the US; and, hogs between Western Canada and Eastern Canada. This finding is troublesome, especially given the fact that the estimation period is in all cases rather short and therefore more likely to represent a stable data generating process.

4. Spatial models for the North-American livestock market

The main objective of this section is to construct a simple three-region spatial equilibrium model for slaughter steers and heifers, and hogs. Before doing that, however, a brief review of the applications of spatial equilibrium models is in order.

4.1. Modeling applications of the competitive statial equilibrium model

Samuelson (1952) first showed that the maximization of social pay-off, defined as consumer surplus of all countries plus producer surplus of all countries, will produce the competitive spatial equilibrium solution described in section 4. The usefulness of this result for empirical applications was underscored by Takayama and Judge (1964), who showed that, given linear demand and supply functions in each country and a matrix of transportations costs, Samuelson's problem involves the maximization of a quadratic objective function subject to a set of linear constraints. This led to a number of empirical applications of this framework in agricultural economics, an example of which is Pieri, Meilke, and MacAulay's (1977) North American-Japanese pork trade model. In this approach, linear demand and supply functions for each country are estimated econometrically. Once these functions are known, with all non-price variables evaluated at the reference time period and collapsed into the intercept, the spatial price configuration is solved by quadratic programming techniques. In addition to transportation costs, these models can easily incorporate the effects of tariffs and quota restrictions. A distinct feature of these normative spatial equilibrium models is that they solve for a matrix of trade flows.

Another class of trade models is that of non-spatial trade equilibrium models. Thompson (1981) describes three main versions of this kind of model, which differ in the way the price linkage conditions are specified. In general, transportation costs are not explicitly introduced in the model, but implicitly estimated. Domestic prices in each of the (N-1) regions can be linked to that of the N^{th} region, and this last price is solved by the world demand and supply identity (Griffith and Meilke, 1982). Alternatively, domestic prices can be linked pairwise along the principal trade flow routes, as in the USDA's GOL model (Rojko et al., 1978). If one is interested in solving for the net trade position of the regions, without explicitly retrieving bilateral trade flows, only (N-1) price linkages are necessary. This has been the rule in most modeling efforts, and has prompted Thompson to claim that this class of models cannot provide any information on the souce-destination of trade flows. This claim is incorrect. By including N(N-1)/2 price linkage equations, the model allows for the solution of all the bilateral trade flows X_{ij} (with $X_{ji} \equiv -X_{ij}$). The real problem with econometric spatial equilibrium models concerns their ability to satisfy the requirements of the competitive spatial equilibrium model. To be fully consistent, the price linkage equations should be introduced as conditional identities, such that the linkage would hold for positive trade flows only. This would force the number of non-zero trade flows to equal at most (N-1) out of the possible N(N-1)/2. The problem with this is that the solution technique cannot be simple matrix inversion (if the equations are linear), but would require an algorithm able to find the fixed point of the solution set, such as the one developed by MacKinnon (1975), which virtually reduces the model to a normative spatial equilibrium model. The introduction of price linkages as continuous functions, either identities or estimated relationships, allows the system to be solved by matrix inversion, or by Newton-Raphson techniques (if non-linear).

The above discussion makes it clear that normative spatial equilibrium models, of which quadratic programming models have been the most commonly applied, are better suited to satisfy the competitive spatial equilibrium conditions. Also, most policies affecting trade, including import quotas, can be introduced very easily in this type of model. The limitation of linear demands and supplies of quadratic programming can be overcome by the current availability of nonlinear programming techniques (Fox, 1986). However, it has been observed that normative spatial equilibrium models do not explain real world trade flows very well, yielding much more specialized trade patterns than those observed in reality (Thompson, 1981). The information requirements of these models is also fairly high, and the results are very sensitive to transportation cost data which is difficult to determine with accuracy. Finally, the strict adherence of the models to the competitive equilibrium conditions may turn out to be a questionable advantage, as these conditions may be violated to some degree in reality.

Econometric spatial equilibrium models are not fully consistent with the conditions of the competitive spatial equilibrium model, but they are somewhat simpler to solve. The effects of tariffs can be introduced easily, although quantitative restrictions are particularly difficult to handle. Transport costs may be used or, if not available, they can be implicitly estimated in the price linkage equations. Indeed, estimating the price linkage equations rather than introducing them as identities makes these equations catch-all instruments, which can explain virtually any observed spatial price configuration. This distinct flexibility of econometric spatial equilibrium models is however ambiguous, and it is not always clear what kind of departures from the competitive conditions are accounted for in this fashion.

4.2. An empirical application of normative models

In this section, a simple implementation of normative spatial equilibrium models is presented. The application explicitly considers three regions: Western Canada, Eastern Canada, and the United States. While the discussion in section 2.2 suggests that there is some scope for considering vertically related markets simultaneously, for simplicity one product at a time will be considered. As the theoretical review has made clear, the product must be homogeneous, and the quantities considered must closely reflect the price of interest. For these reasons, we choose to model the market for slaughter steers and heifers in the beef sector, and the market for hogs in the pork sector. For each region the supply is assumed pre-determined, and therefore completly inelastic, while the demand function is assumed to be of the form:

$$Q = \alpha P^{\beta}$$

where β is the constant elasticity of demand, and α is a constant to be determined at the calibration stage. More details are provided for each case below.

4.2.1. A spatial model for slaughter steers and heifers

The results of the spatial equilibrium exercise for slaughter steers and heifers is reported in Table 22. For each region, the first row (row a) reports the actual data observed in 1984, which is choosen to be the benchmark data set. Demand is defined as the carcass weight equivalent of total marketings in each region, since this gives the amount of livestock slaughtered in each region. Thus, in 1984 we had 924.2 millions pounds slaughtered in Western Canada, 511.7 in Eastern Canada, and 17,497.1 in the United States. The average price observed in 1984 was (in C$/cwt, with the average exchange rate of C$ 1 = US$ 0.772): 75.63 in Western Canada, 85.28 in Eastern Canada, and 84.64 in the United States. Transportation costs between the two Canadian regions can be deduced from Table 8. In 1984, the average rail rate for a single deck livestock shipment from Calgary to Toronto was $ 2097 per car. Since one can fit about 40,000 lbs of live weight in each car, a good approximation for transport costs is 10 $/cwt of carcass weight. There is not as good information for transport costs between the two Canadian regions and the US. Based on the transport cost between EC and WC, and the spatial price differences observed in 1984, we assume that the transportation cost between Canada and the US is 8 C$/cwt, to which one has to add the 1 US$/cwt tariff.

Given this data, the model was calibrated (by chosing the α coefficients of the demand functions) so as to replicate exactly the demand, supply, and total trade flow in each region, and the price in the US region. The calibration exercise can be carried out for any value of the demand elasticity. Given that we are considering a short-run adjustment model with fixed supply, a reasonably inelastic derived demand elasticity seems appropriate. Thus, a value of -0.4 for the coefficient β is assumed for every region. It should be noted that, since a competitive spatial equilibrium model with three regions admits at most two trade flows, the observed trade flows in 1984 cannot be generated by the model, although total net trade for each region is replicated exactly. Also, since transportation costs have been assumed a priori, we can only replicate exactly the equilibrium price in one region, which is chosen to be the largest one (the United States).

With the above assumptions, the model was solved using the generalized transportation problem (GTP) algorithm coded by F.D. Holland (1985) for a microcomputer with a math co-processor. This procedure allows non-linear demand functions of the form assumed, and belongs to the class of fixed-point algorithms. The benchmark solution is reported in row b, for each region, in Table 22. The trade flows generated by the model imply that Western Canada is a net exporter to both the other regions. A feature of the solution set is that the prices of two trading regions will differ by exactly the transportation cost and the tariff amount. Thus the price difference generated between Western and

Table 22 - Three-Region Spatial Equilibrium Model for the North-American Market of Slaughter Steers and Heifers

		demand	supply	net exports: to WC	net exports: to EC	net exports: to US	price	price difference: with WC	price difference: with EC	price difference: with US
		mills lbs carcass weight					canadian dollars			
WC	a	924.2	1014.4	-	25.2	65.0	75.63	-	-9.65	-9.01
	b	924.2	1014.4	-	36.1	54.1	75.34	-	-10.00	-9.29
	t	933.4	1014.4	-	40.6	40.5	73.51	-	-10.00	-11.29
	s	960.6	1014.4	-	53.8	0.0	68.40	-	-10.00	-8.93
	d	879.0	1014.4	-	13.8	121.6	85.41	-	-10.00	-9.29
EC	a	511.7	475.6	-25.2	-	-10.9	85.28	9.65	-	0.64
	b	511.7	475.6	-36.1	-	0.0	85.34	10.00	-	0.70
	t	516.2	475.6	-40.6	-	0.0	83.51	10.00	-	-1.29
	s	529.4	475.6	-53.8	-	0.0	78.40	10.00	-	1.07
	d	489.4	475.6	-13.8	-	0.0	95.41	10.00	-	0.71
US	a	17551.2	17497.1	-65.0	10.9	-	84.64	9.01	-0.64	-
	b	17551.2	17497.1	-54.1	0.0	-	84.64	9.29	-0.70	-
	t	17537.6	17497.1	-40.5	0.0	-	84.80	11.29	1.29	-
	s	18197.0	18197.0	0.0	0.0	-	77.33	8.93	-1.07	-
	d	17618.7	17497.1	-121.6	0.0	-	94.70	9.29	-0.71	-

Note: a - actual values observed in 1984;
b - benchmark simulation for 1984;
t - simulated $ 2 increase in transportation costs between WC and US;
s - simulated 4 % increase in US supply;
d - simulated 5 % increase in the constant coefficient of US demand.

Eastern Canada is \$ 10 (compared to an observed difference of \$ 9.65), and the price difference between Western Canada and the US is \$ 9.29 (compared with an observed \$ 9.01). On the other hand, the price difference between two non-trading regions will be bounded by plus and minus transport costs and tariffs, but no exact prediction is possible. The model generates a difference of \$ 0.70 between Eastern Canada and the US, which is very close to the observed difference of \$ 0.64. Thus, despite a trade flow of 10.9 millions pounds observed between Eastern Canada and the United States in 1984, the price difference observed was very close to the one implied by a more specialized pattern of trade.

In addition to the values observed and those of the benchmark solution, Table 22 reports the results of three experiments. The first one postulates an increase of C\$ 2 in transport costs between Western Canada and the US, and these results are reported in row t for each region. As a result of this, the price difference between Western Canada and the US increases by exactly this amount. Given that Western Canada is very small compared to the US, most of the price change is experienced by Western Canada. Given that the prices in Western and Eastern Canada are still related by exactly the same transportation costs, the price in Eastern Canada is depressed by exactly the same amount as in Western Canada (\$ 1.83). It follows that in this case the price difference between the two non-trading regions has changed, even if the transport cost between the two has not. This result is possibly of wider interest for understanding the price differences between Canada and the US. For products being exported to the US, what we are observing are in fact price differences between two surplus regions which are not trading with each other. Thus, for instance, changing transfer costs between the US midwest and the US deficit regions may affect the price difference between Canada and the US midwest price even if the transfer costs between these two regions are kept constant.

Rows s in Table 22 report the result of a US supply shock. The increase in US supply of 4% represents what is required to make the US self-sufficient in slaughter steers and heifers. Under this scenario, the price in both Canadian regions drops by \$ 6.94 from the benchmark solution, while the US price drops by \$ 7.31 . The demand shock experiment (row d in Table 22) postulates and increse of 5% in the α coefficient of US demand. This scenario raises prices in all regions by \$ 10.07, with a large increase in Western Canada exports towards the US, and a decrese in Eastern Canada imports. These large price changes are clearly the result of the assumed complete rigidity of supply in all regions.

4.2.2. A spatial model for hogs

While in the spatial equilibrium model for slaughter steers and heifers we have assumed constant transportation costs between any two regions, the econometric results reported in part two of this study strongly support the hypothesis of transportation costs increasing with quantity traded. Thus, in this section the the assumption of constant transportation costs is relaxed. To do so we assume that transportation costs are implicitly estimated by the restricted OLS estimates reported in Tables 14, 19,and 22, which illustrates another possible use for the econometric estimates of price linkage equations. Equation d in Table 12, when evaluated at the 1984 mean values, yields the following transfer cost function for Eastern Canada exports to the US:

(16) $t_{24} = 4.6010 + 0.1906\ X_{24}$

where t_{24} is the transfer cost, and X_{24} is the quarterly net trade between Eastern Canada and the US. If we evaluate this expression for the average quarterly export level in 1984, then we have $t_{24} = 8.80$. Similarly, from equation d in Table 17 we get the transfer function:

(17) $t_{14} = 4.7069 + 0.3105\ X_{14}$

which, when evaluated at the value of average quarterly trade in 1984, gives $t_{14} = 12.36$ as the estimated transportation cost between Western Canada and the US. Similarly, one could derive a transportation cost between Eastern Canada and Western Canada from the results in Table 20. However, since it is clear that the trade flows of the model will imply zero trade in hogs between Eastern and Western Canada, without loss of generality it can be assumed that the transportation cost between Eastern and Western Canada is the same constant (10 $/cwt) used for slaughter steers and heifers. In this case, the derived demand for hogs is assumed to have a constant elasticity of -0.5 in all regions. Given the above assumptions, the model was calibrated to replicate the supply, demand, and total trade flows in each region, and the price in the US region. The results of this exercise are reported in Table 23 (for Western Canada), Table 24 (for Eastern Canada), and Table 25 (for the US). The values in row a in these tables report the values observed in 1984, while row b reports the benchmark simulation results for 1984. It can be seen that the benchmark solution overestimates the price by almost a dollar in Western Canada, and by 55 cents in Eastern Canada.

Three experiments are carried out for comparison with the benchmark solution: the US supply is increased by 3%, the constant in the US

Table 23 - Three-Region Spatial Equilibrium Model for the North-American Market of Hogs: Western Canada

	demand	supply	net exports to WC	net exports to EC	net exports to US	price	price difference with WC	price difference with EC	price difference with US
	mills lbs carcass weight					canadian dollars			
a	547.9	646.6	-	0.1	98.6	68.85	-	-4.00	-13.35
b	547.9	646.6	-	0.0	98.7	69.84	-	-3.56	-12.36
sc	564.7	646.6	-	0.0	81.9	65.74	-	-3.56	-12.36
sv	561.1	646.6	-	0.0	85.4	66.60	-	-3.84	-11.35
dc	531.5	646.6	-	0.0	115.1	74.22	-	-3.56	-12.36
dv	534.7	646.6	-	0.0	111.9	73.33	-	-3.29	-13.40
tc	563.5	646.6	-	0.0	83.1	66.02	-	-3.56	-16.75
tv	560.2	646.6	-	0.0	86.4	66.82	-	-3.81	-15.80

Note:
a - actual values observed in 1984;
b - benchmark simulation for 1984;
sc - simulated 3 % increase in US supply with constant transportation costs;
sv - simulated 3 % increase in US supply with varying transportation costs;
dc - simulated 3 % increase in US demand constant coefficient with constant transportation costs;
dv - simulated 3 % increase in US demand constant coefficient with varying transportation costs;
tc - simulated US countervailing duty with constant transportation costs;
tv - simulated US countervailing duty with varying transportation costs.

Table 24 - Three-Region Spatial Equilibrium Model for the North-American Market of Hogs: Eastern Canada

	demand	supply	net exports to WC	net exports to EC	net exports to US	price	price difference with WC	price difference with EC	price difference with US
	mills lbs carcass weight					canadian dollars			
a	1290.6	1378.7	-0.1	-	88.2	72.85	4.00	-	-9.35
b	1290.6	1378.7	0.0	-	88.1	73.40	3.56	-	-8.80
sc	1290.6	1378.7	0.0	-	50.5	69.30	3.56	-	-8.80
sv	1290.6	1378.7	0.0	-	61.2	70.44	3.84	-	-7.51
dc	1253.8	1378.7	0.0	-	124.9	77.78	3.56	-	-8.80
dv	1263.2	1378.7	0.0	-	115.5	76.62	3.29	-	-10.11
tc	1325.6	1378.7	0.0	-	53.1	69.58	3.56	-	-13.19
tv	1315.7	1378.7	0.0	-	63.0	70.63	3.81	-	-11.99

Note: a - actual values observed in 1984;
b - benchmark simulation for 1984;
sc - simulated 3 % increase in US supply with constant transportation costs;
sv - simulated 3 % increase in US supply with varying transportation costs;
dc - simulated 3 % increase in US demand constant coefficient with constant transportation costs;
dv - simulated 3 % increase in US demand constant coefficient with varying transportation costs;
tc - simulated US countervailing duty with constant transportation costs;
tv - simulated US countervailing duty with varying transportation costs.

Table 25 - Three-Region Spatial Equilibrium Model for the North-American Market of Hogs: United States

	demand	supply	net exports to WC	net exports to EC	net exports to US	price	price difference with WC	price difference with EC	price difference with US
	mills lbs carcass weight					canadian dollars			
a	14718.0	14531.2	-98.6	-88.2	-	82.20	13.35	9.35	-
b	14718.0	14531.2	-98.7	-88.1	-	82.20	12.36	8.80	-
sc	14718.0	14967.1	-81.9	-50.5	-	78.10	12.36	8.80	-
sv	14718.0	14967.1	-85.4	-61.2	-	77.95	11.35	7.51	-
dc	14771.3	14531.2	-115.1	-124.9	-	86.58	12.36	8.80	-
dv	14758.6	14531.2	-111.9	-115.5	-	86.73	13.40	10.11	-
tc	14667.4	14531.2	-83.1	-53.1	-	82.77	16.75	13.19	-
tv	14680.6	14531.2	-86.4	-63.0	-	82.62	15.80	11.89	-

Note: a - actual values observed in 1984;
b - benchmark simulation for 1984;
sc - simulated 3 % increase in US supply with constant transportation costs;
sv - simulated 3 % increase in US supply with varying transportation costs;
dc - simulated 3 % increase in US demand constant coefficient with constant transportation costs;
dv - simulated 3 % increase in US demand constant coefficient with varying transportation costs;
tc - simulated US countervailing duty with constant transportation costs;
tv - simulated US countervailing duty with varying transportation costs.

demand equation is increased by 3%, and the US introduces the countervailing duty of C$ 4.39. These three experiments are evaluated both assuming that the transportation cost is constant, and that the transportation cost is a function of quantity traded as described in (16) and (17). None of these experiments changes the benchmark solution for the direction of trade flows, which implies Eastern and Western Canada both export to the US. The effect of US supply increasing is to depress prices in all three regions, while US demand increasing raises the prices in all regions. However, the implications are slightly different if varying transportation costs are assumed, as price variations in Western and Eastern Canada are dampened in either direction, while US price variation is increased. Thus, with variable transportation costs only part of the variability originating in the US market is transmitted to the Canadian market.

Of some interest is the analysis of the effects of the countervailing duty of 4.39 C$/cwt imposed by the United States in 1985. Under constant transportation costs, the price in both Eastern and Western Canada declines by C$ 3.82, while it is increased by C$ 0.57 in the US. If transfer costs are allowed to vary with trade, the hog price declines by only C$ 2.77 in Eastern Canada, and by C$ 3.02 in Western Canada, while it increases by C$ 0.42 in the US. Again it is interesting to note that the price differences between two non-trading regions (in this case Eastern and Western Canada) do not change, under the various experiments, if all transportation costs are assumed constant. However, if transfer costs between trading regions depend partly on bilateral trade flows, as exogenous shocks affect trade flows they will also affect the end value of the transfer costs, and thus affect the price difference between non-trading regions in a manner already illustrated in the case of slaughter steers.

5. Conclusions

Predicting the price of livestock in Canada given the price in the US is crucial to the econometric efforts of Agriculture Canada. The first part of this report has illustrated the behaviour of spatial price spreads in the North-American livestock sector. The first impression is that of increased size and variability of price spreads, especially when the post-1975 data are compared to the pre-1973 data. When price differences are analyzed within a theoretically consistent model, however, and the analysis is concentraded over a period of monotonic trade flows in a resonably recent period, the results of section three indicate that the estimated econometric models can account for a large portion of observed price variability. The reasonable predictive accuracy of the estimated price linkage equations, and the lack of heteroscedasticity in the estimated residuals, suggest that these equations can provide satisfactory results for forecasting and policy analysis. The simulation exercises reported in section four clarify the main feature of the competitive spatial equilibrium model, emphasize the fact that price differences between two region that do not trade directly can display great variability, and show some of the effects of having transportation costs dependent on the volume of trade flows.

The results of both the econometric analysis in section three, and the simulation analysis in section four, should be evaluated in the light of the competitive spatial equilibrium assumptions. Trade flows and spatial price differences are obviously affected if any of the assumptions of the competitive model are violated. A violation which has received some attention in empirical applications is that of product homogeneity. If the elasticity of substitution between domestically produced goods and imported goods, or between imported goods from different sources, is less than infinity, then the imported good should have its own demand, and spatial price differentials will reflect this preference bias. While livestock products, such as those analyzed in this study, may appear to belong to a fairly homogeneous lot, the departure from one of the price coefficient of the price linkage equations, especially for feeder calves and slaughter cows, provides some evidence of product differentiation. A class of models that can accomodate this possibility is that of Armington's (1969) differentiation by country of origin. These models can generate trade flows between all pairs of trading countries, and yield the competitive spatial equilibrium solution as a special case, and may provide a possible avenue to model the North-American livestock market.

The static nature of the competitive spatial equilibrium solution is also likely to be too strong an assumption in empirical models based on time series data, especially when the frequency of the data is quarterly or monthly. The econometric spatial equilibrium model can accomodate this problem with a dynamic specification of the price linkage equations. However, some analysis conducted along these lines, but not reported in this study, provides little evidence of dynamic adjustment in the price linkage equations.

Even when the assumptions of the competitive spatial equilibrium model are satisfied in reality, empirical applications of it may still be found to be wanting because of aggregation problems. Three types of aggregation should be considered: aggregation across commodities, aggregation across space, and aggregation through time. Aggregation across commodities is typically justified by degrees of freedom arguments, and by the fact that disaggregated data is difficult to assemble. Since the specialization induced by free trade may occur within rather than between commodity groups, as the growing literature on intra-industry trade indicates (Tharakan, 1983), it is clear that analysis of commodity aggregates may give misleading results. In our analysis we have avoided aggregation as much as allowed by the data base. Still some aggregation is present, for instance by pooling feeder calves and feeder cattle, slaughter steers and heifers, or light hogs and sows. While something may be gained by a greater degree of specificity, it is clear that for the model to maintain some relevance for applied econometric modeling some aggregation is required. Aggregation across space occurs when several geographical locations are aggregated into a single region for the purpose of empirical analysis. The raises the possibility, already mentioned in this study, that prices of two regions that are not really trading with each other are compared. A more realistic model would decompose the US into several regions, and the relevant price to be linked to the Canadian price would be the price of a region directly trading with Canada. Finally, aggregation through time occurs because we are comparing average prices for a certain period, say a quarter, which in principle could be characterized by very uneven price differentials and trade flows. While monthly and weekly data can lessen the inerent time aggregation bias of quarterly or annual data, the dynamic adjustment problem in this case will likely become more serious.

REFERENCES

Armington, P.S. "A Theory of Demand for Products Distinguished by Place of Production." IMF Staff Papers, 16(1969):159-178.

Bressler, R.G., and King, R.A. Markets, Prices, and Interregional Trade. New-York: J. Wiley, 1970.

Caves, R.E., and Jones, R.W. World Trade and Payments, fourth edition. Little-Brown, 1985.

Fox, G. Mathematical Programming with MINOS: A Handbook for Economists. Department of Agricultural Economics and Business, University of Guelph, December 1986.

Griffith, G.R. and Meilke, K.D. A Structural Econometric Model of the World Markets for Rapeseed, Soybeans and their Products. School of Agricultural Economics and Extension Education, University of Guelph, April 1982.

Holland, F.D. GTP: A Microcomputer Program for the Spatial Equilibrium Problem. USDA, ERS Staff Report No. AGES850514. Washington, D.C., October 1985.

Johnston, J. Econometric Methods, third edition. New-York: McGraw-Hill, 1984.

Judge, G.G., Griffiths, W.E., Hill, R.C., Lutkepohl, H., and Lee, T-C. The Theory and Practice of Econometrics, second edition. New-York: J. Wiley, 1985.

MacKinnon, J.G. "An Algorithm for the Generalized Transportation Problem." Regional Science and Urban Economics, 5(1975):445-464.

Moschini, G., and Meilke, K.D. "Parameter Stability and the US Demand for Beef." Western Journal of Agricultural Economics, 9(1984):271-282.

Pieri, R., Meilke, K.D., and MacAuley, T.G. "North American-Japanese Pork Trade Model: An Application of Quadratic Programming." Canadian Journal of Agricultural Economics, 25(1977):61-79.

Samuelson, P.A. "Spatial Price Equilibrium and Linear Programming." American Economic Review, 42(1952):283-303.

Takayama, T. and Judge, G.G. "Equilibrium among Spatially Separated Markets: A Reformulation." Econometrica, 32(1964):510-524.

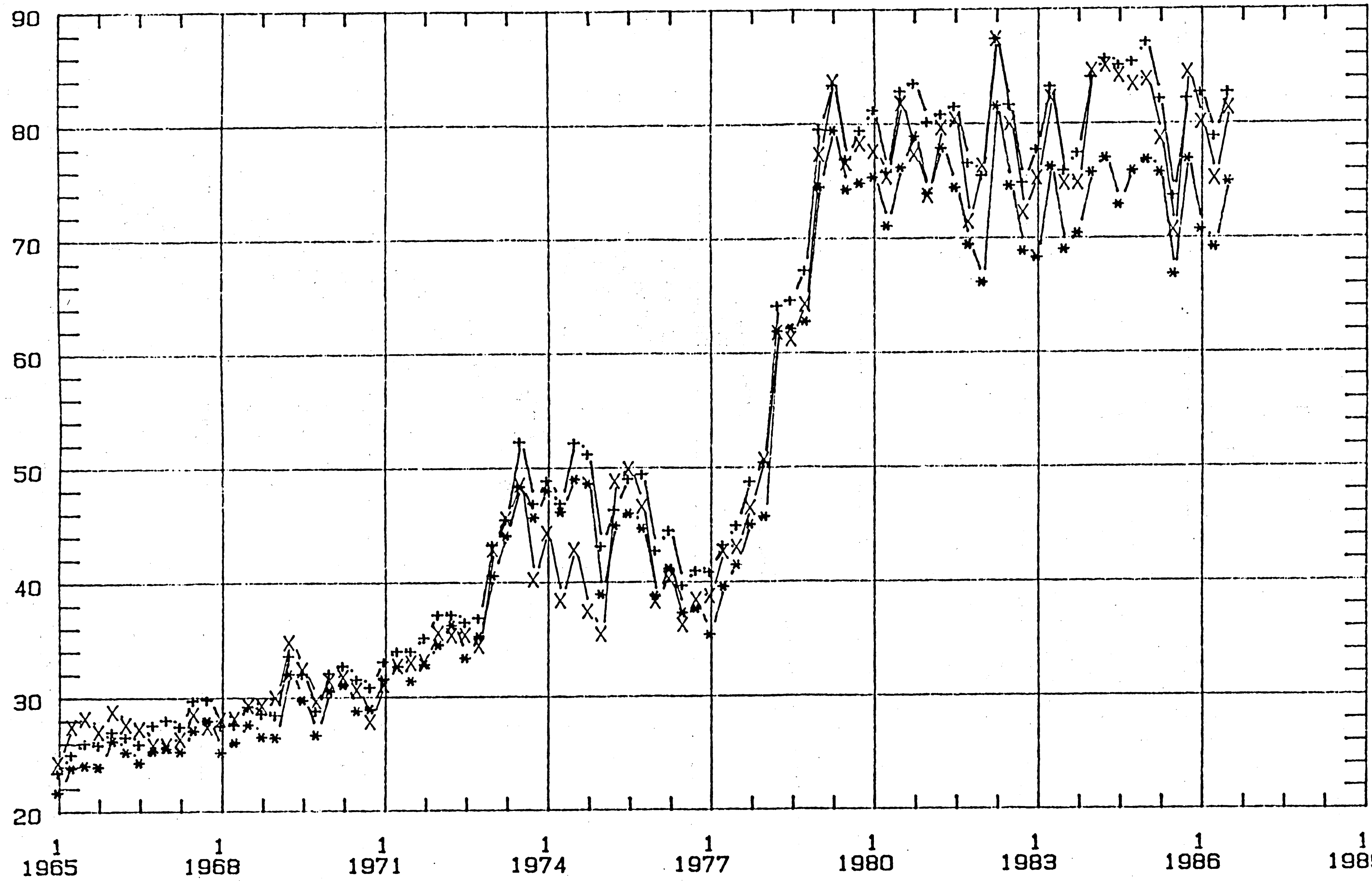
Tharakan, P.K.M. Intra-Industry Trade. Amsterdam: North-Holland, 1983.

Thompson, R.L. A Survey of Recent Developments in International Agricutural Trade Models. USDA, ERS, Biblographies and Literature of Agriculture No. 21, September 1981.

APPENDIX A - PRICES AND PRICE SPREADS IN THE LIVESTOCK SECTOR

FIGURE A1

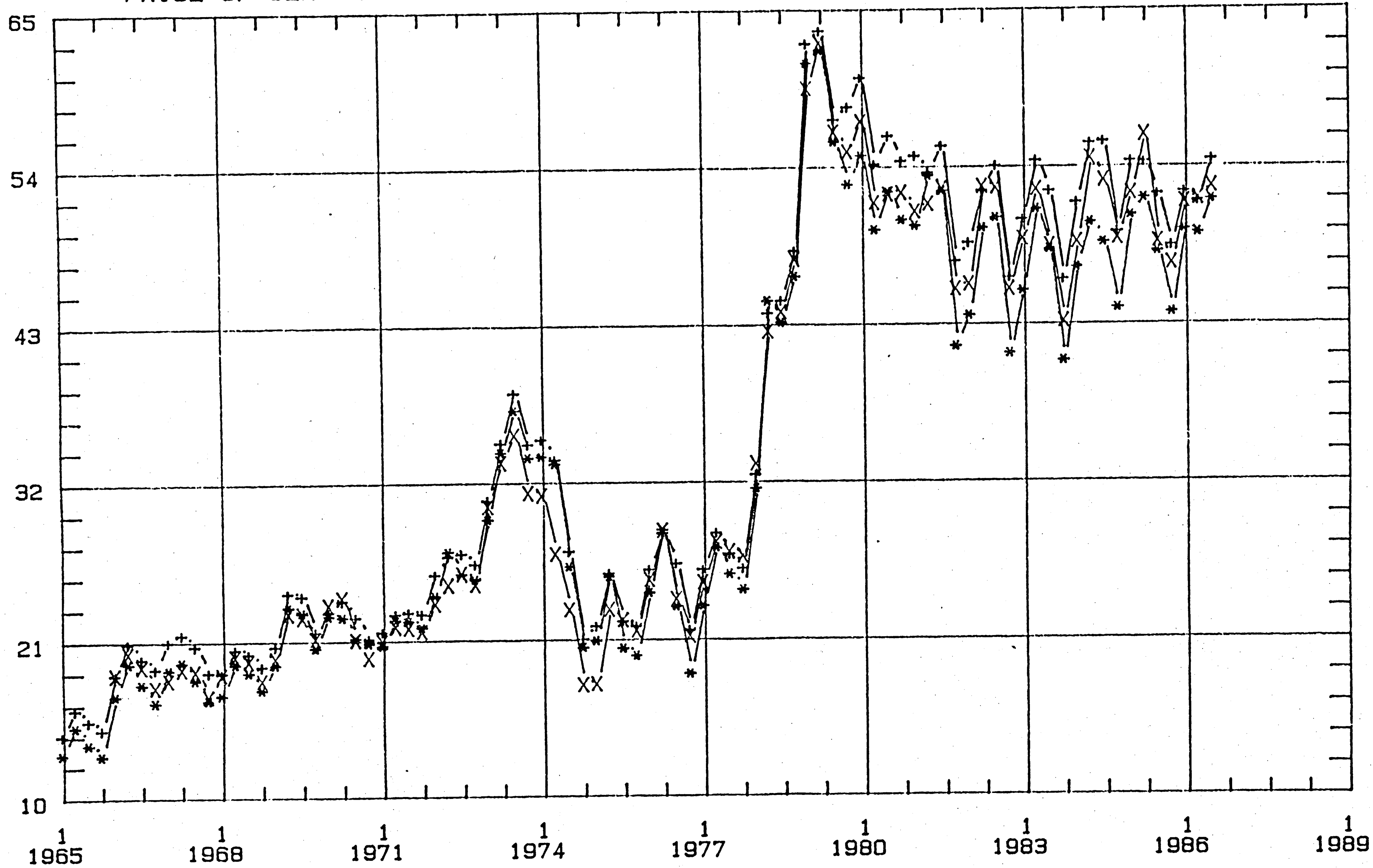
PRICE OF SLAUGHTER CATTLE TORONTO, CALGARY AND U. S. (OMAHA), C$/CWT.



SYMBOL		SCALE	VARIABLE
———	+	(20, 90)	PSS2
———	*	(20, 90)	PSS1
———	X	(20, 90)	PSS4C

FIGURE A2

PRICE OF SLAUGHTER COWS TORONTO, CALGARY AND U. S. (OMAHA), C$/CWT.



SYMBOL	SCALE	VARIABLE
+	(10, 65)	PBW2
*	(10, 65)	PBW1
X	(10, 65)	PBW4C

FIGURE A3

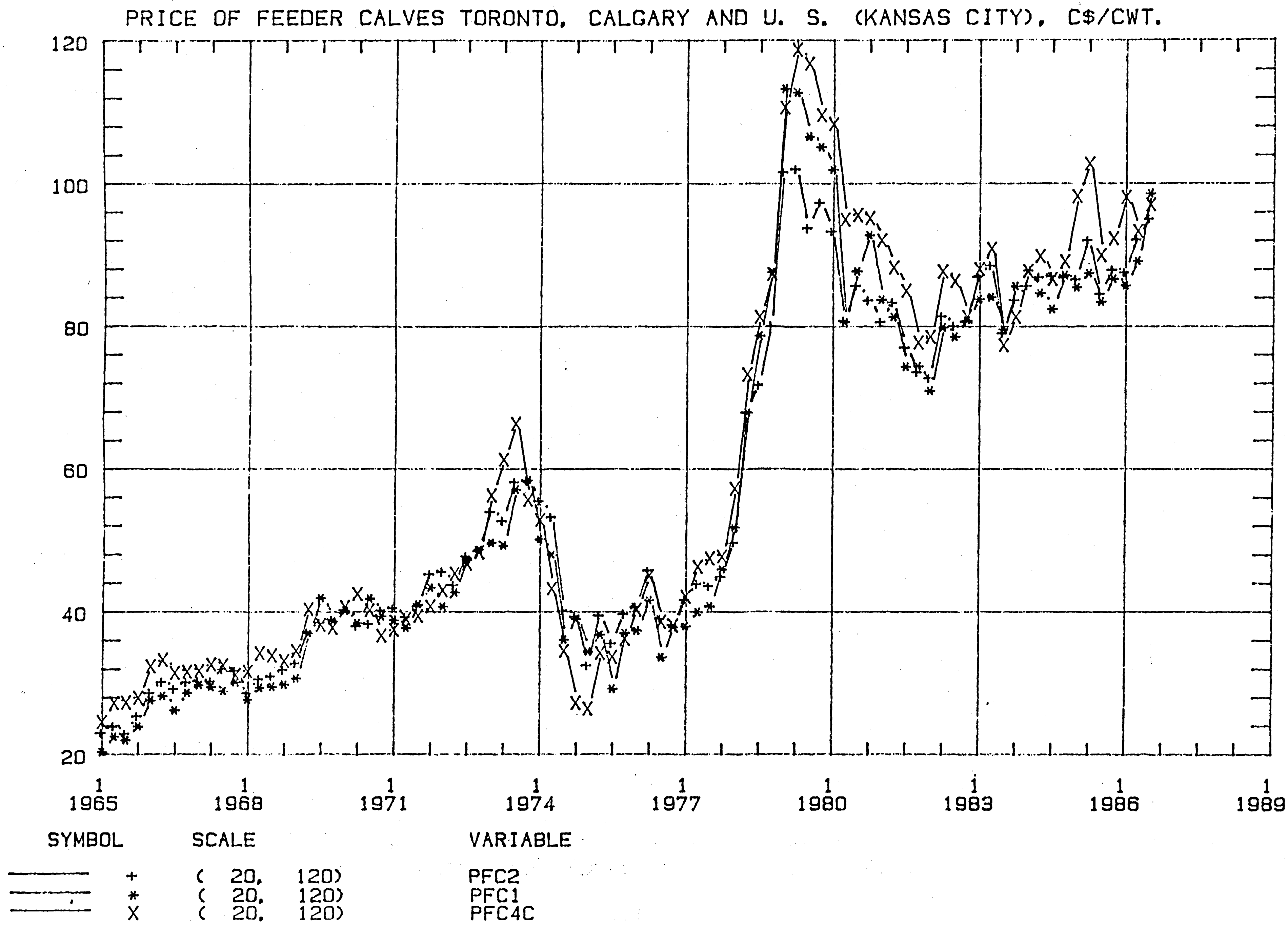

PRICE OF FEEDER CALVES TORONTO, CALGARY AND U. S. (KANSAS CITY), C$/CWT.
120
100
80
60
40
20
1 1965
1 1968
1 1971
1 1974
1 1977
1 1980
1 1983
1 1986
1 1989
SYMBOL SCALE VARIABLE
+ (20, 120) PFC2
* (20, 120) PFC1
X (20, 120) PFC4C

FIGURE A4

PRICE OF HOGS TORONTO, EDMONTON AND U.S. (7-MKTS.), C$/CWT.

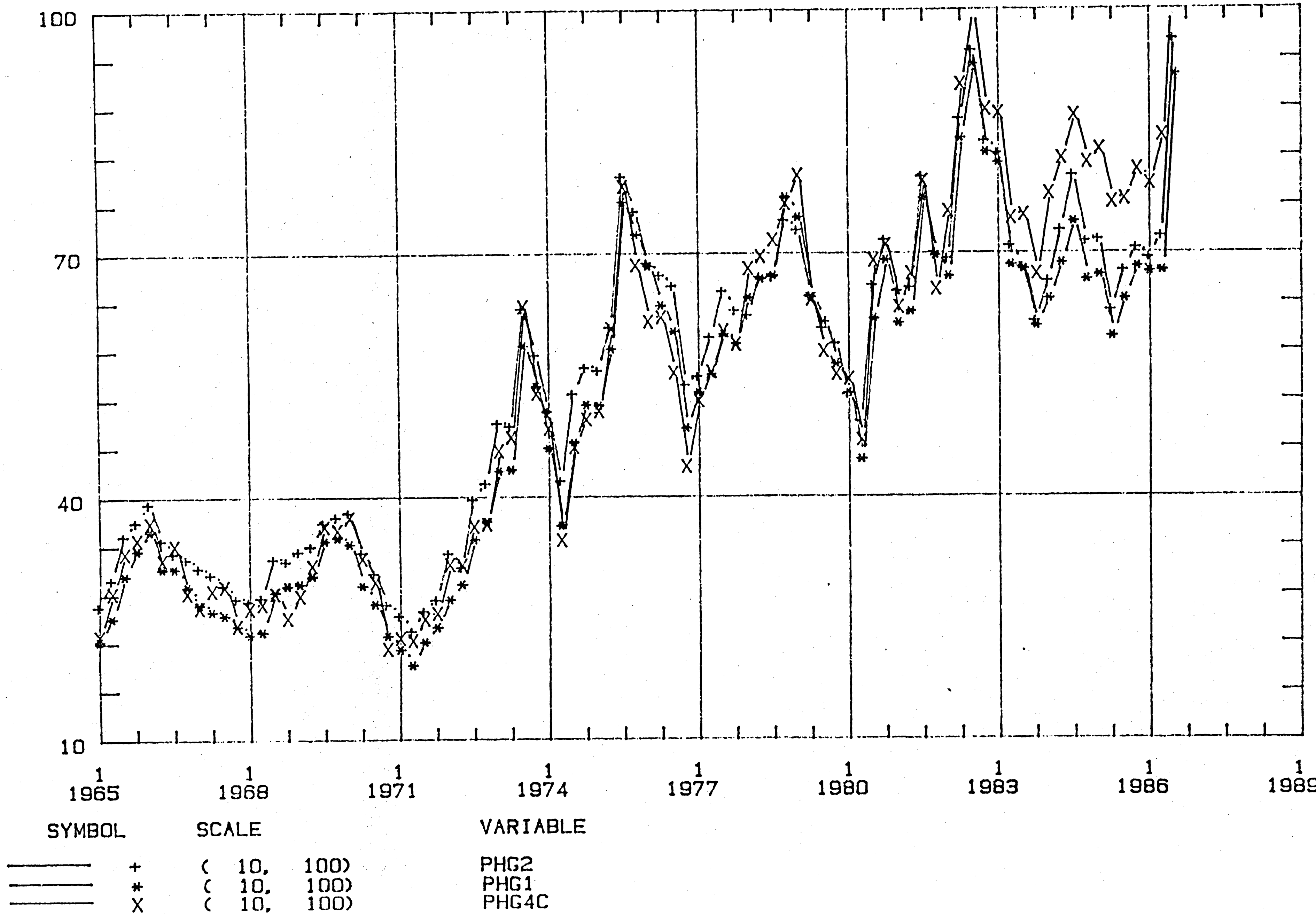


FIGURE A5

PRICE OF SLAUGHTER LAMBS TORONTO AND U.S. (SAN ANGELO), C$/CWT.

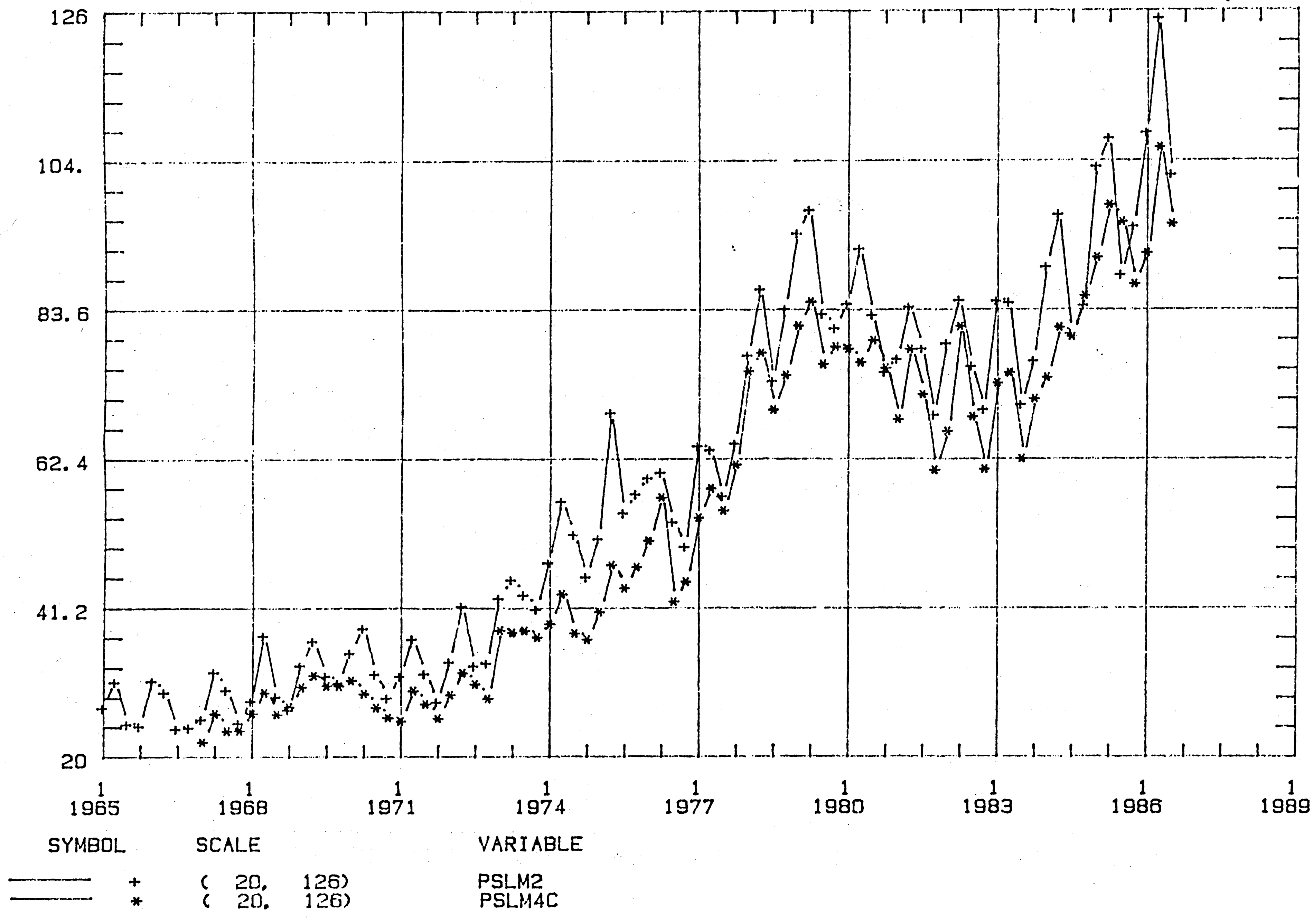


FIGURE A6

TORONTO-OMAHA AND CALGARY-OMAHA PRICE DIFFERENCES FOR SLAUGHTER CATTLE.

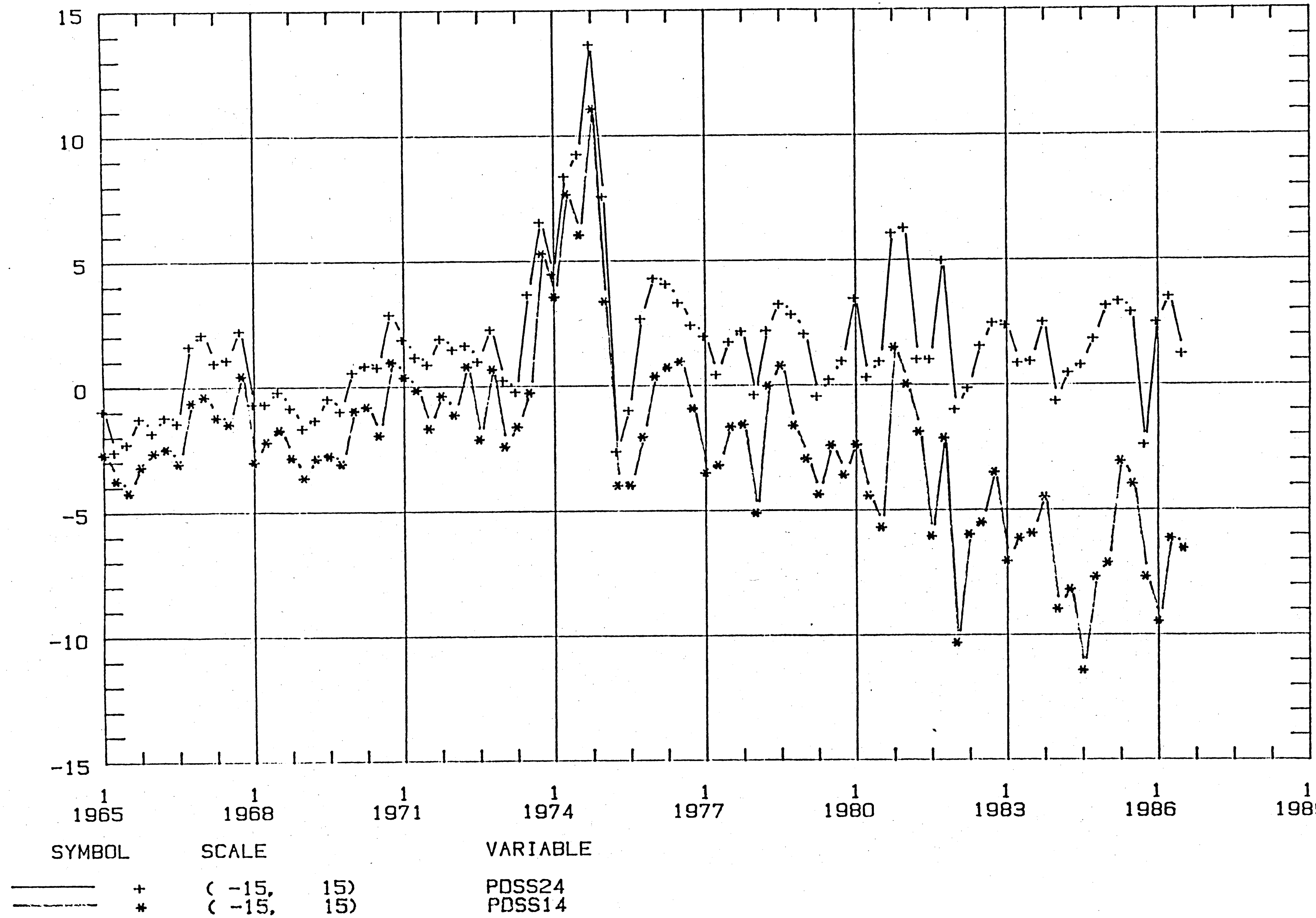
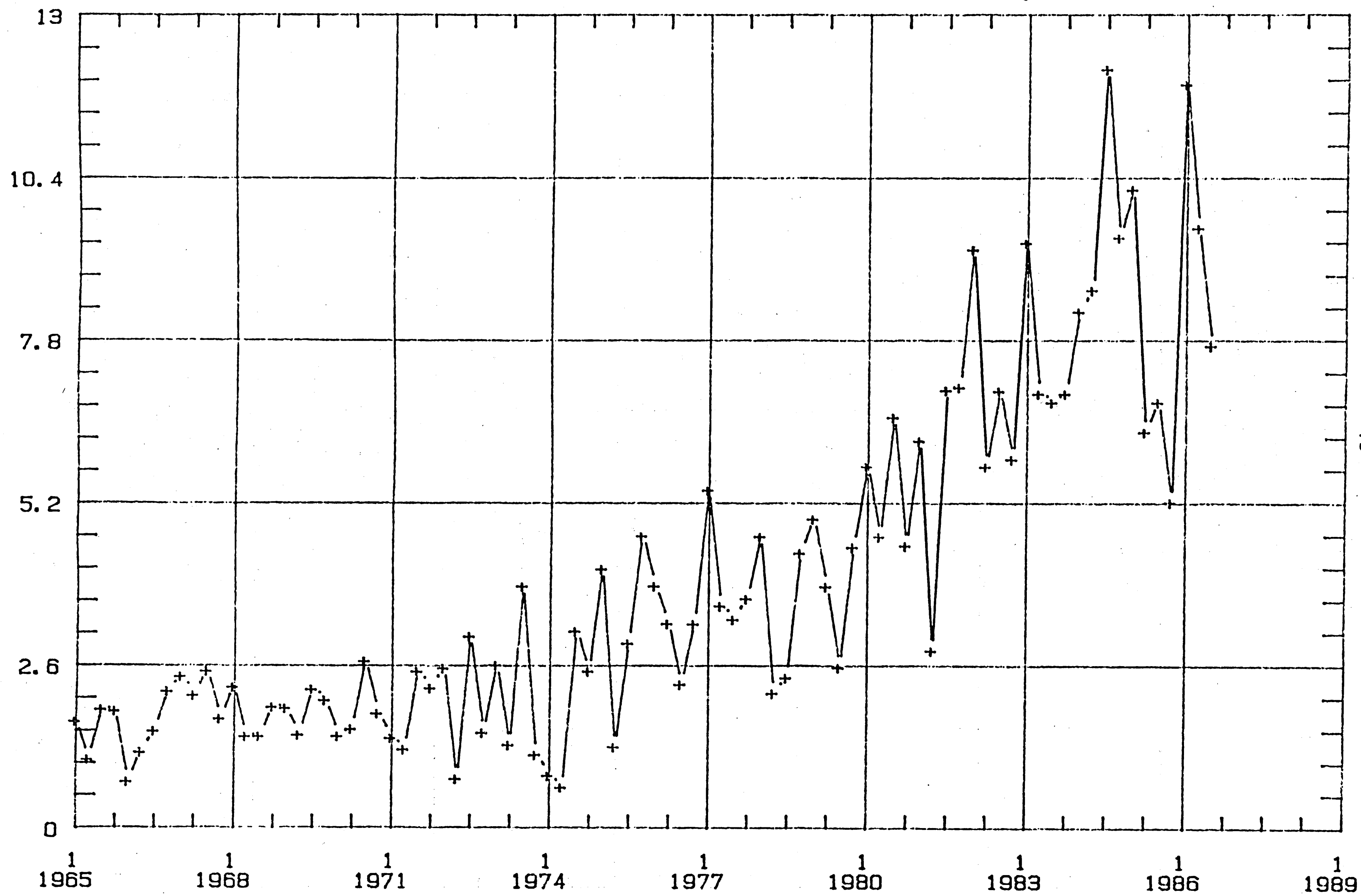


FIGURE A7

TORONTO-CALGARY PRICE DIFFERENCE FOR SLAUGHTER CATTLE. C$/CWT.



SYMBOL SCALE VARIABLE

——— + (0, 13) PDSS21

FIGURE A8

TORONTO-OMAHA AND CALGARY-OMAHA PRICE DIFFERENCES FOR SLAUGHTER COWS, C$/CWT.

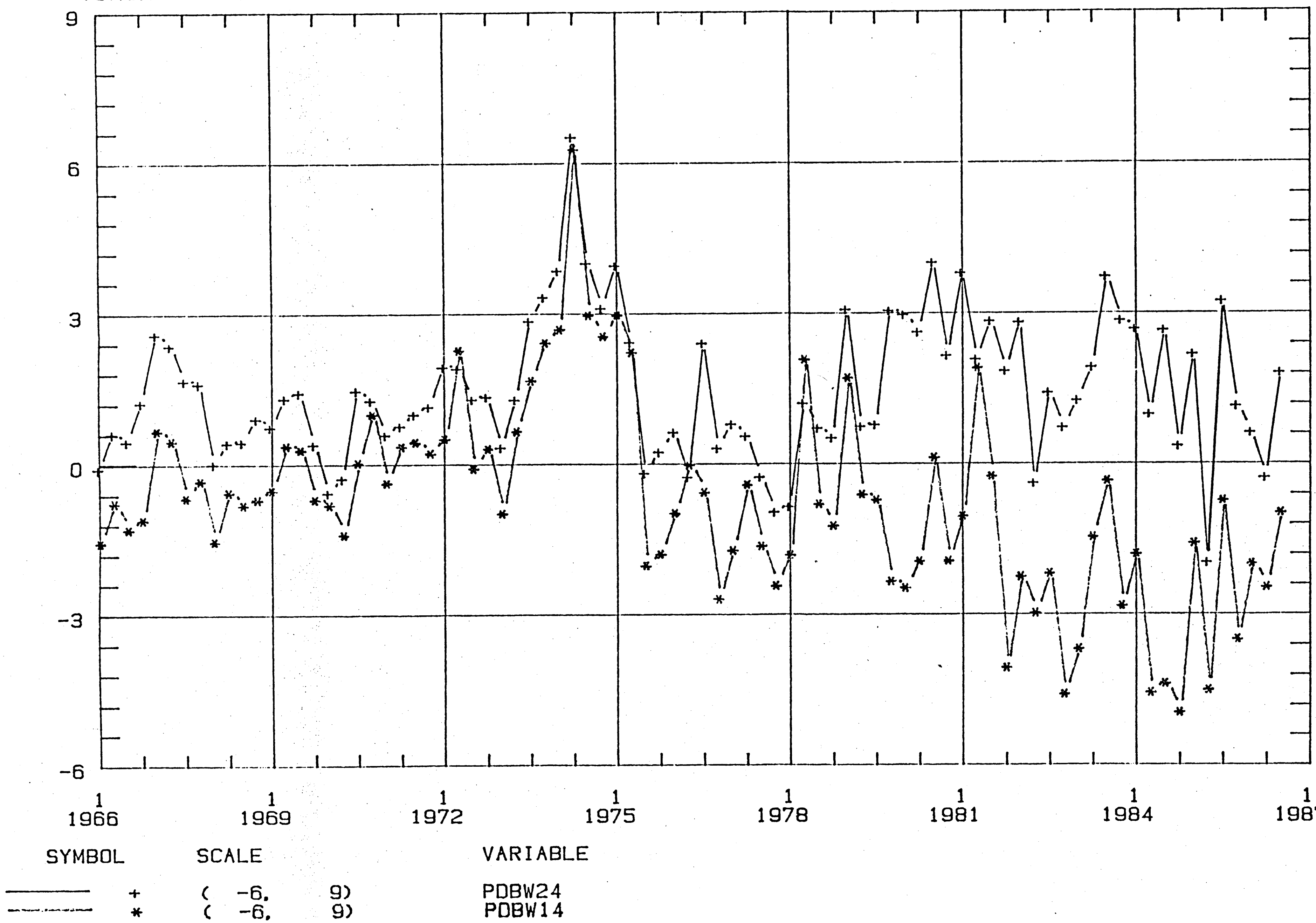
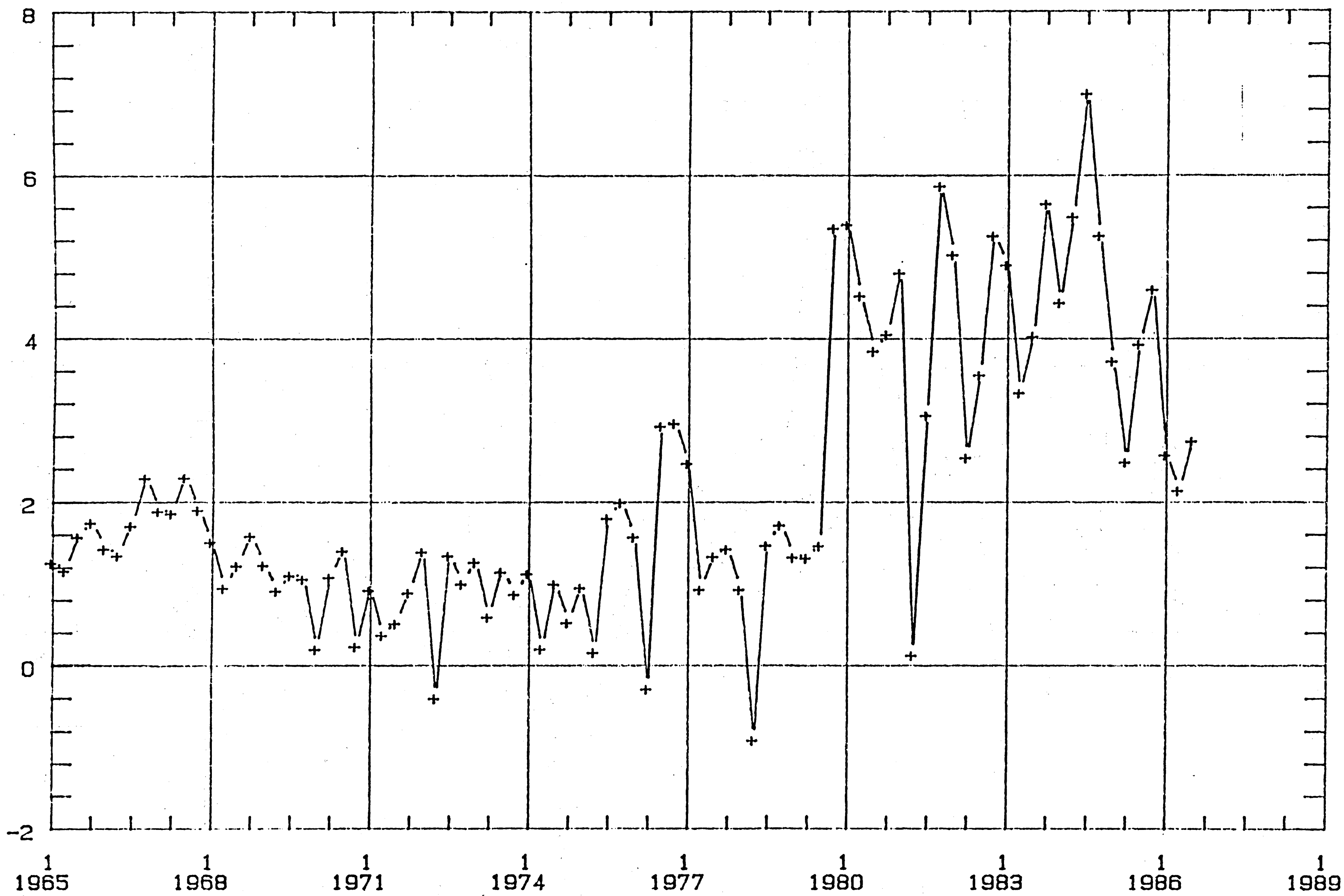


FIGURE A9

TORONTO-CALGARY PRICE DIFFERENCE FOR SLAUGHTER COWS, C$/CWT.



SYMBOL SCALE VARIABLE

+ (-2, 8) PDBW21

FIGURE A10

TORONTO-U.S. AND CALGARY-U.S. PRICE DIFFERENCES FOR FEEDER CALVES.

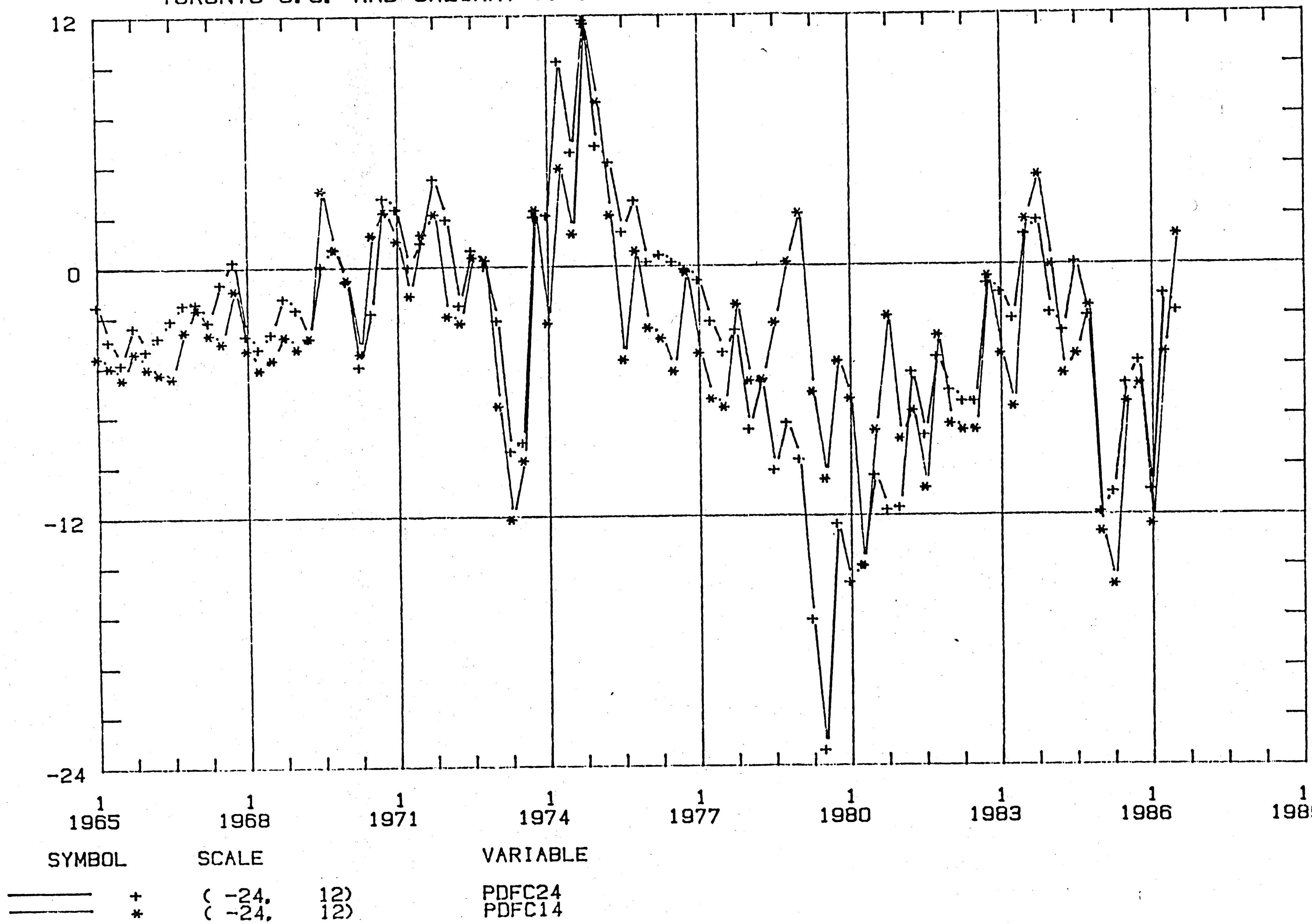
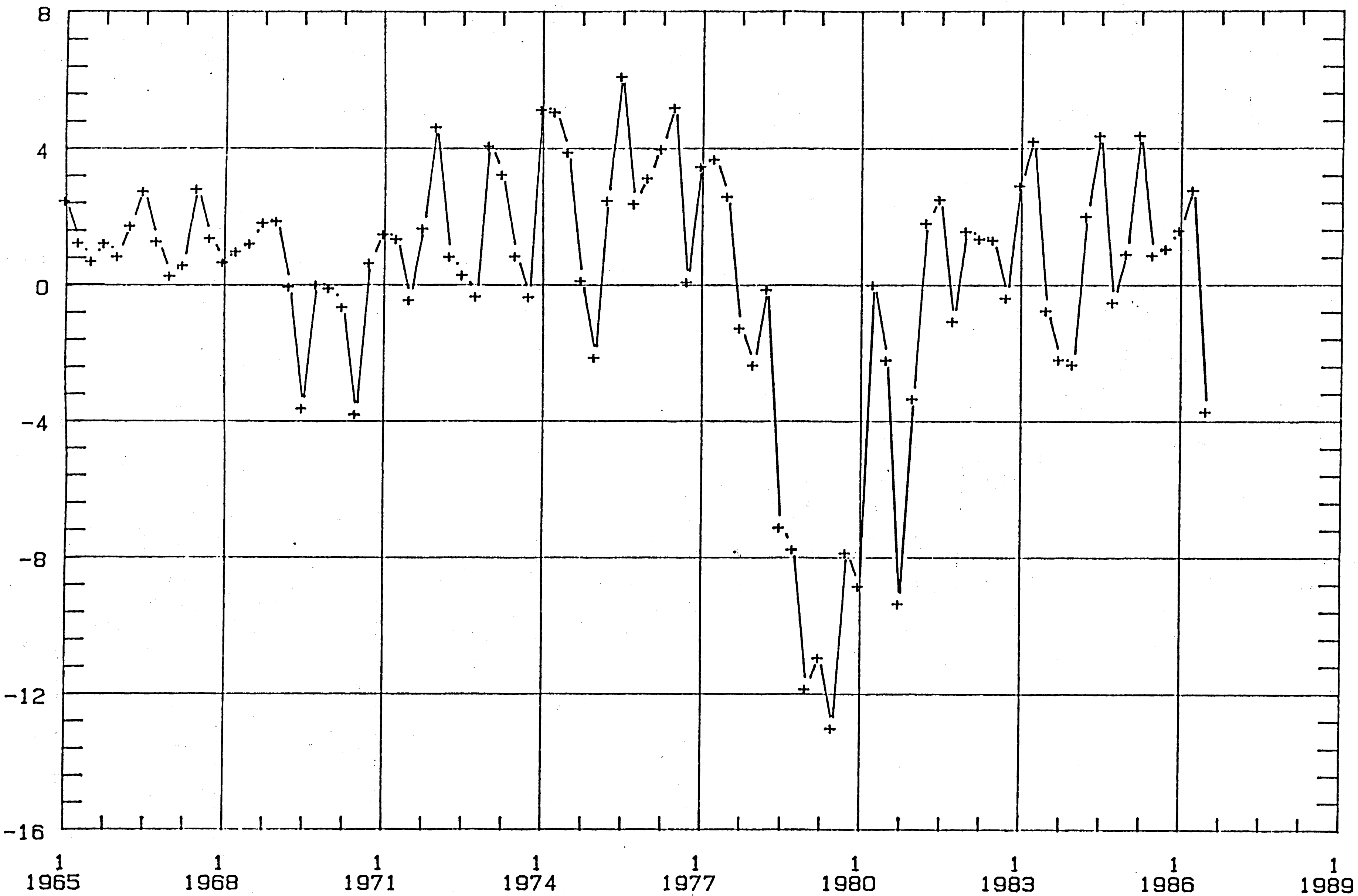


FIGURE A11

TORONTO-CALGARY PRICE DIFFERENCE FOR FEEDER CALVES, C$/CWT.



SYMBOL	SCALE	VARIABLE
+	(-16, 8)	PDFC21

FIGURE A12

TORONTO-U.S. AND EDMONTON-U.S. PRICE DIFFERENCES FOR HOGS, C$/CWT.

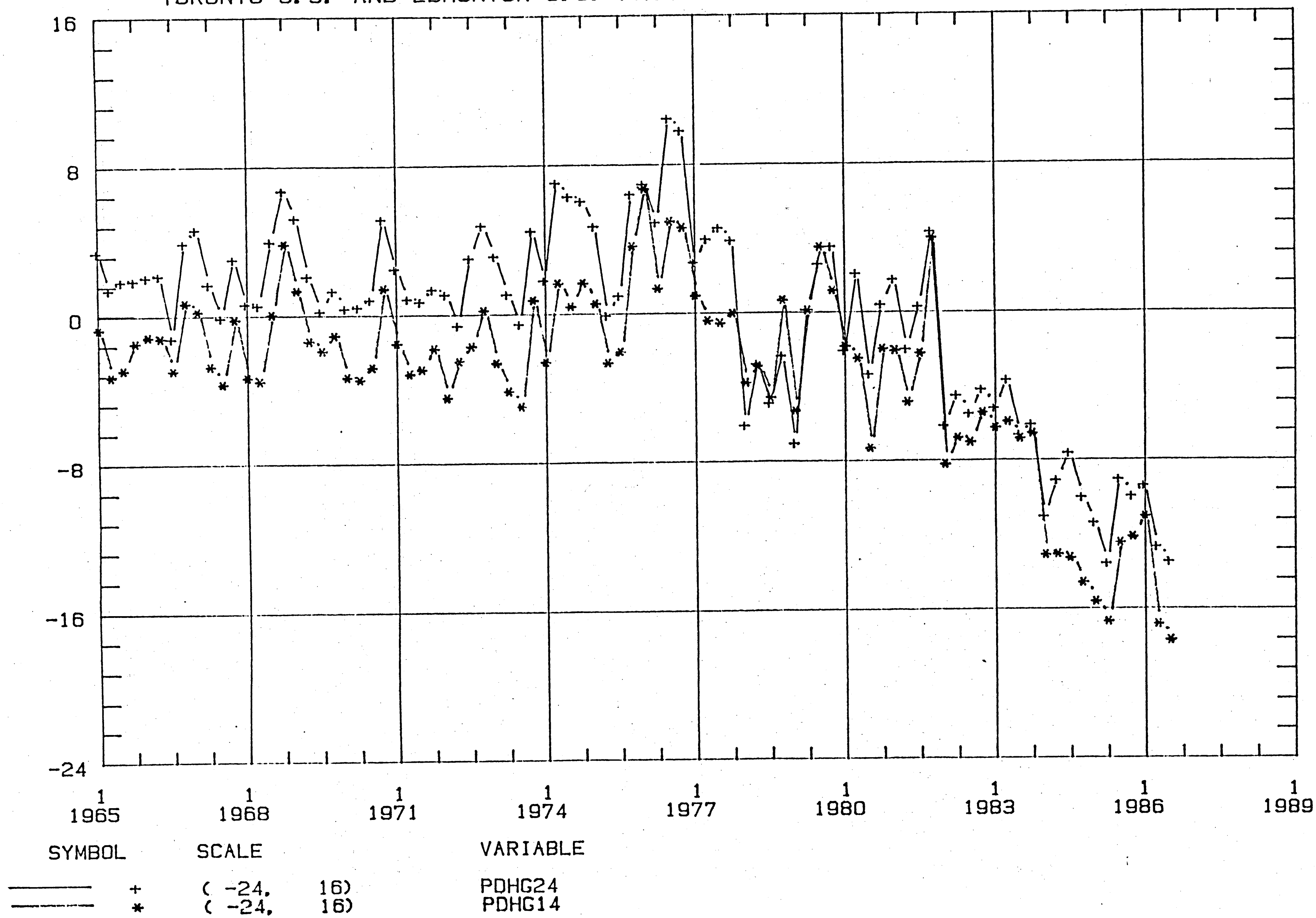


FIGURE A13

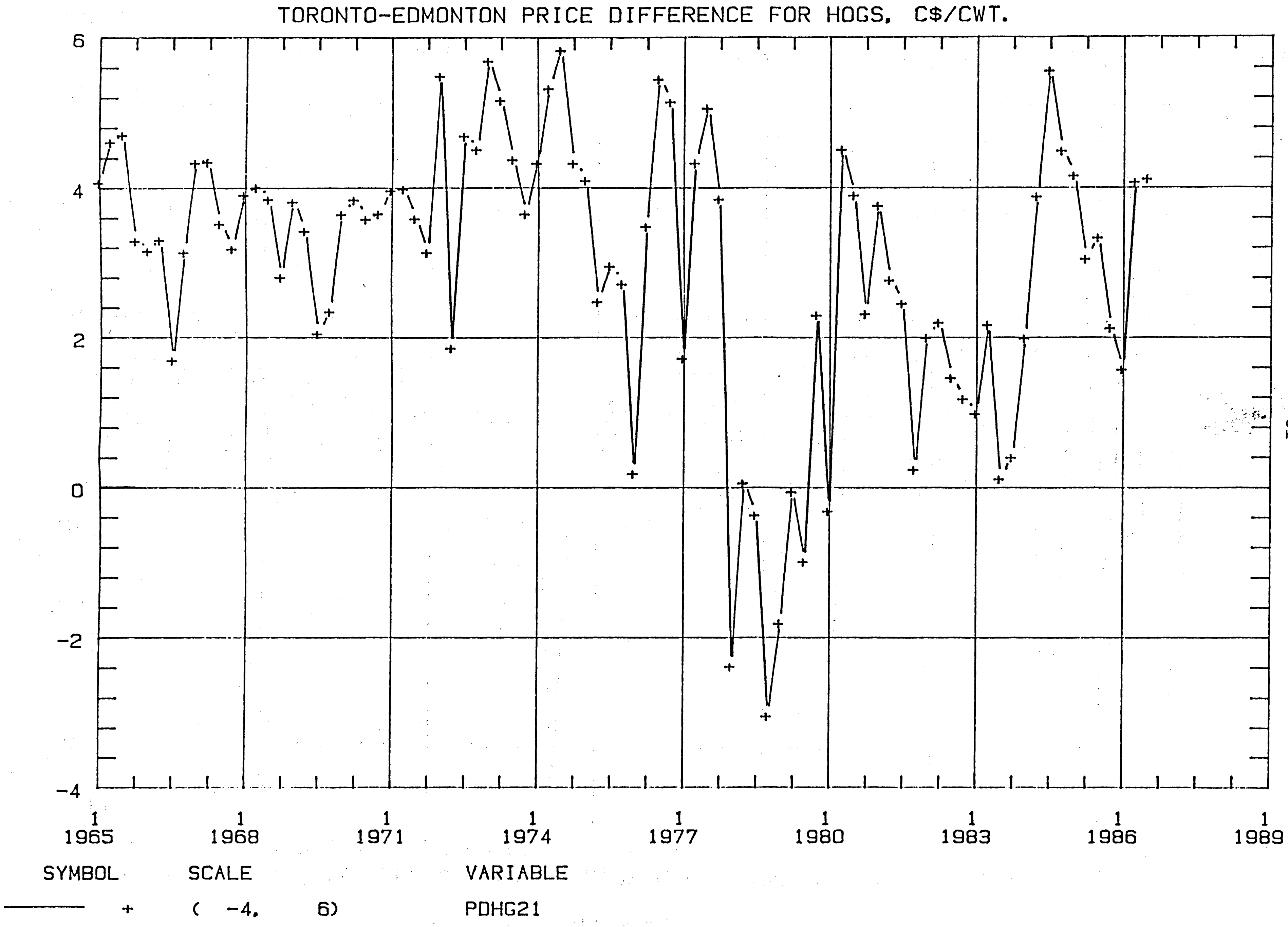
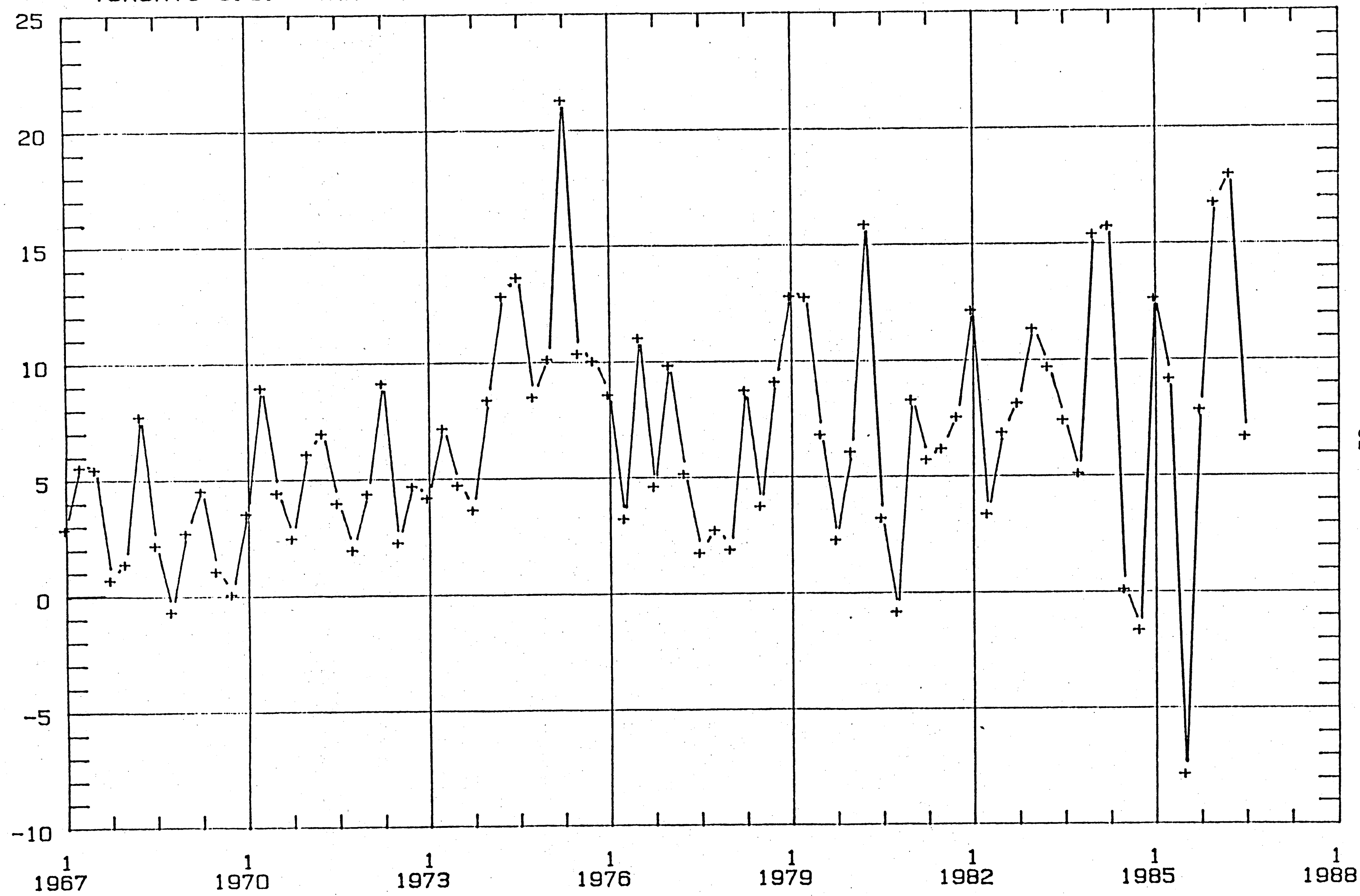

TORONTO-EDMONTON PRICE DIFFERENCE FOR HOGS, C$/CWT.
6
4
2
0
-2
-4
1
1965
1
1968
1
1971
1
1974
1
1977
1
1980
1
1983
1
1986
1
1989
SYMBOL
SCALE
VARIABLE
+
(-4, 6)
PDHG21

FIGURE A14

TORONTO-U.S. (SAN ANGELO) PRICE DIFFERENCE FOR SLAUGHTER LAMBS, C$/CWT.



SYMBOL	SCALE	VARIABLE
——— +	(-10, 25)	PDLM24

APPENDIX B - PRICE DIFFERENCE LEVELS AND VARIABILITY

TABLE B1 - PRICE DIFFERENCES FOR SLAUGHTER STEERS

	obs	mean	var	cv
TORONTO - OMAHA				
66 1 - 70 4...............	20.	0.17	2.02	12.03
71 1 - 75 4...............	20.	3.32	15.88	4.78
76 1 - 80 4...............	20.	2.18	2.89	1.33
81 1 - 86 3...............	23.	1.81	3.7	2.05
66 1 - 86 3...............	83.	1.87	7.05	3.78
mean equality test		5.65		
probability F(3,79)		0.00		
variance equality test...			24.76	
probability CHI(3).......			0.	
CALGARY - OMAHA				
66 1 - 70 4...............	20.	-1.71	1.63	0.95
71 1 - 75 4...............	20.	1.06	16.18	15.29
76 1 - 80 4...............	20.	-1.85	4.7	2.55
81 1 - 86 3...............	23.	-5.94	7.79	1.31
66 1 - 86 3...............	83.	-2.25	13.91	6.19
mean equality test		23.80		
probability F(3,79)		0.00		
variance equality test...			19.97	
probability CHI(3).......			0.	
TORONTO - CALGARY				
66 1 - 70 4...............	20.	1.88	0.23	0.12
71 1 - 75 4...............	20.	2.26	1.37	0.61
76 1 - 80 4...............	20.	4.02	1.42	0.35
81 1 - 86 3...............	23.	7.75	4.61	0.59
66 1 - 86 3...............	83.	4.11	7.7	1.87
mean equality test		78.82		
probability F(3,79)		0.00		
variance equality test...			39.2	
probability CHI(3).......			0.	

TABLE B2 - PRICE DIFFERENCES FOR SLAUGHTER COWS

	obs	mean	var	cv
TORONTO - OMAHA				
67 1 - 70 4..............	16.	1.03	0.8	0.78
71 1 - 75 4..............	20.	2.13	2.79	1.31
76 1 - 80 4..............	20.	1.25	2.02	1.61
81 1 - 86 3..............	23.	1.71	2.	1.17
67 1 - 86 3..............	79.	1.56	2.06	1.32
mean equality test		2.27		
probability F(3,75)		0.09		
variance equality test...			7.34	
probability CHI(3).......			0.06	
CALGARY - OMAHA				
67 1 - 70 4..............	16.	-0.27	0.53	1.98
71 1 - 75 4..............	20.	1.22	3.79	3.11
76 1 - 80 4..............	20.	-0.97	1.7	1.76
81 1 - 86 3..............	23.	-2.34	3.02	1.29
67 1 - 86 3..............	79.	-0.67	4.09	6.08
mean equality test		19.58		
probability F(3,75)		0.00		
variance equality test...			15.95	
probability CHI(3).......			0.	
TORONTO - CALGARY				
66 1 - 70 4..............	20.	1.38	0.32	0.23
71 1 - 75 4..............	20.	0.91	0.32	0.35
76 1 - 80 4..............	20.	2.22	2.98	1.35
81 1 - 86 3..............	23.	4.05	2.35	0.58
66 1 - 86 3..............	83.	2.21	3.	1.36
mean equality test		27.41		
probability F(3,79)		0.00		
variance equality test...			40.52	
probability CHI(3).......			0.	

TABLE B3 - PRICE DIFFERENCES FOR FEEDER CALVES

	obs	mean	var	cv
TORONTO - KANSAS CITY				
66 1 - 70 4..............	20.	-1.75	3.79	2.17
71 1 - 75 4..............	20.	1.94	24.83	12.78
76 1 - 80 4..............	20.	-7.6	44.31	5.83
81 1 - 86 3..............	23.	-4.47	16.6	3.71
66 1 - 86 3..............	83.	-3.02	33.47	11.07
mean equality test		14.94		
probability F(3,79)		0.00		
variance equality test...			17.04	
probability CHI(3).......			0.	
CALGARY - KANSAS CITY				
66 1 - 70 4..............	20.	-2.34	7.24	3.1
71 1 - 75 4..............	20.	-0.13	29.87	230.06
76 1 - 80 4..............	20.	-4.63	14.	3.02
81 1 - 86 3..............	23.	-5.37	24.28	4.52
66 1 - 86 3..............	83.	-3.2	22.66	7.08
mean equality test		6.18		
probability F(3,79)		0.00		
variance equality test...			2.96	
probability CHI(3).......			0.4	
TORONTO - CALGARY				
66 1 - 70 4..............	20.	0.59	2.92	4.96
71 1 - 75 4..............	20.	2.07	5.1	2.46
76 1 - 80 4..............	20.	-2.97	35.87	12.08
81 1 - 86 3..............	23.	0.9	5.37	5.96
66 1 - 86 3..............	83.	0.18	15.09	85.74
mean equality test		7.89		
probability F(3,79)		0.00		
variance equality test...			35.62	
probability CHI(3).......			0.	

TABLE B4 - PRICE DIFFERENCES FOR HOGS

	obs	mean	var	cv
TORONTO - U.S. 7-mkts				
66 1 - 70 4..............	20.	2.29	4.55	1.99
71 1 - 75 4..............	20.	2.85	6.1	2.15
76 1 - 80 4..............	20.	1.48	24.32	16.48
81 1 - 86 3..............	23.	-6.64	22.69	3.42
66 1 - 86 3..............	83.	-0.25	30.27	122.97
mean equality test		29.82		
probability F(3,79)		0.00		
variance equality test...			13.92	
probability CHI(3).......			0.	
EDMONTON - U.S. 7-mkts				
66 1 - 70 4..............	20.	-1.12	4.3	3.84
71 1 - 75 4..............	20.	-1.29	5.27	4.1
76 1 - 80 4..............	20.	-0.21	12.83	59.88
81 1 - 86 3..............	23.	-9.19	30.7	3.34
66 1 - 86 3..............	83.	-3.18	27.6	8.69
mean equality test		27.95		
probability F(3,79)		0.00		
variance equality test...			19.26	
probability CHI(3).......			0.	
TORONTO - EDMONTON				
66 1 - 70 4..............	20.	3.41	0.5	0.15
71 1 - 75 4..............	20.	4.13	1.22	0.29
76 1 - 80 4..............	20.	1.69	7.4	4.37
81 1 - 86 3..............	23.	2.55	2.17	0.85
66 1 - 86 3..............	83.	2.93	3.52	1.2
mean equality test		8.05		
probability F(3,79)		0.00		
variance equality test...			36.51	
probability CHI(3).......			0.	

TABLE B5 - PRICE DIFFERENCES FOR SLAUGHTER LAMBS

	obs	mean	var	cv
TORONTO - SAN ANGELO				
68 1 - 71 4..............	16.	3.69	7.63	2.07
72 1 - 76 4..............	20.	8.24	20.74	2.52
77 1 - 81 4..............	20.	6.59	18.17	2.76
82 1 - 86 3..............	19.	8.36	43.53	5.21
68 1 - 86 3..............	75.	6.86	25.42	3.71
mean equality test		3.52		
probability F(3,71)		0.02		
variance equality test...			3.69	
probability CHI(3).......			0.3	

APPENDIX C - ACTUAL AND FITTED VALUES FOR PRICE SPREADS

FIGURE C.1: ACTUAL (PDSS24) AND FITTED (PDSS24F) VALUES FOR TORONTO-U.S. SLAUGHTER STEER PRICE SPREAD (C$/CWT.)

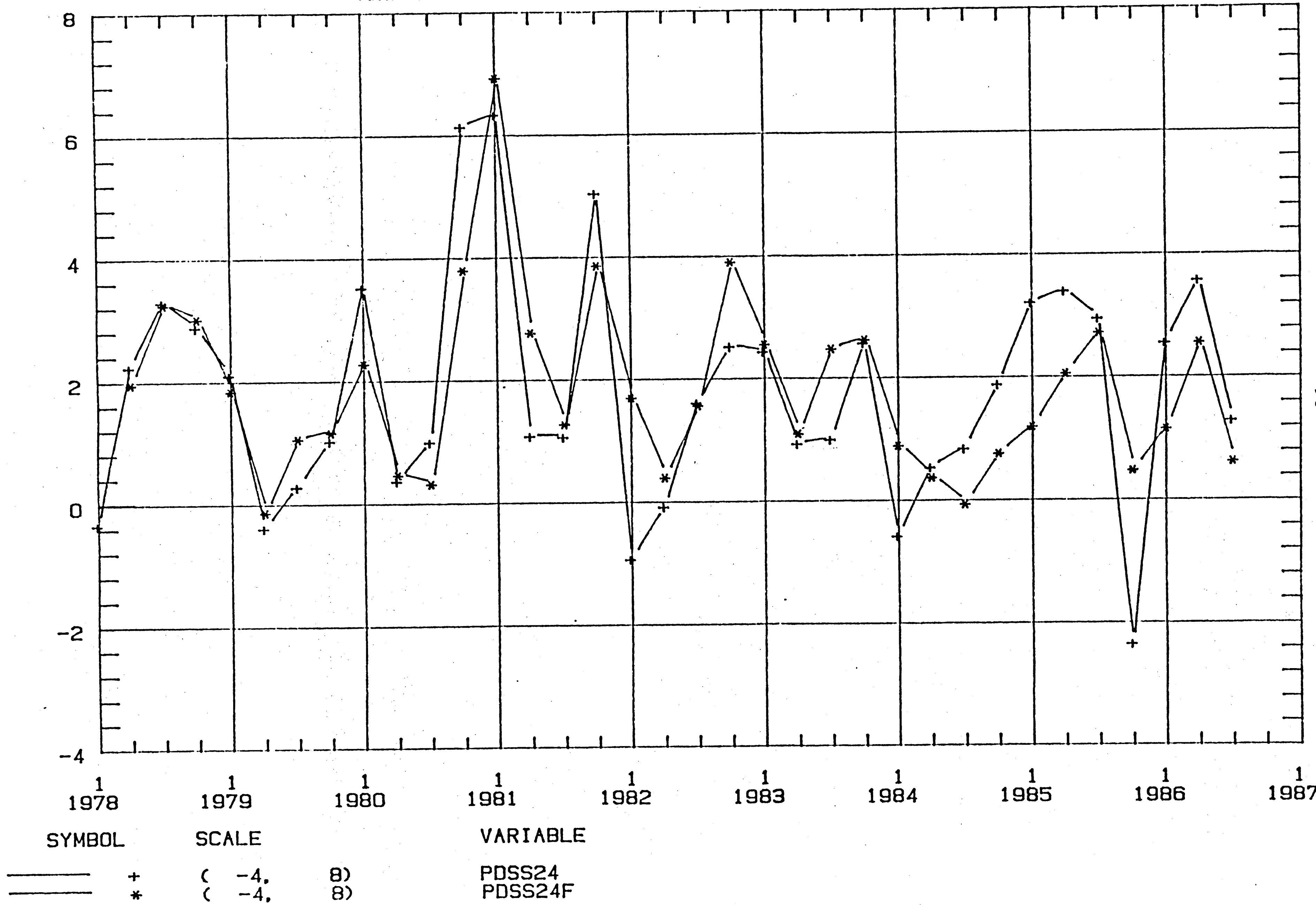
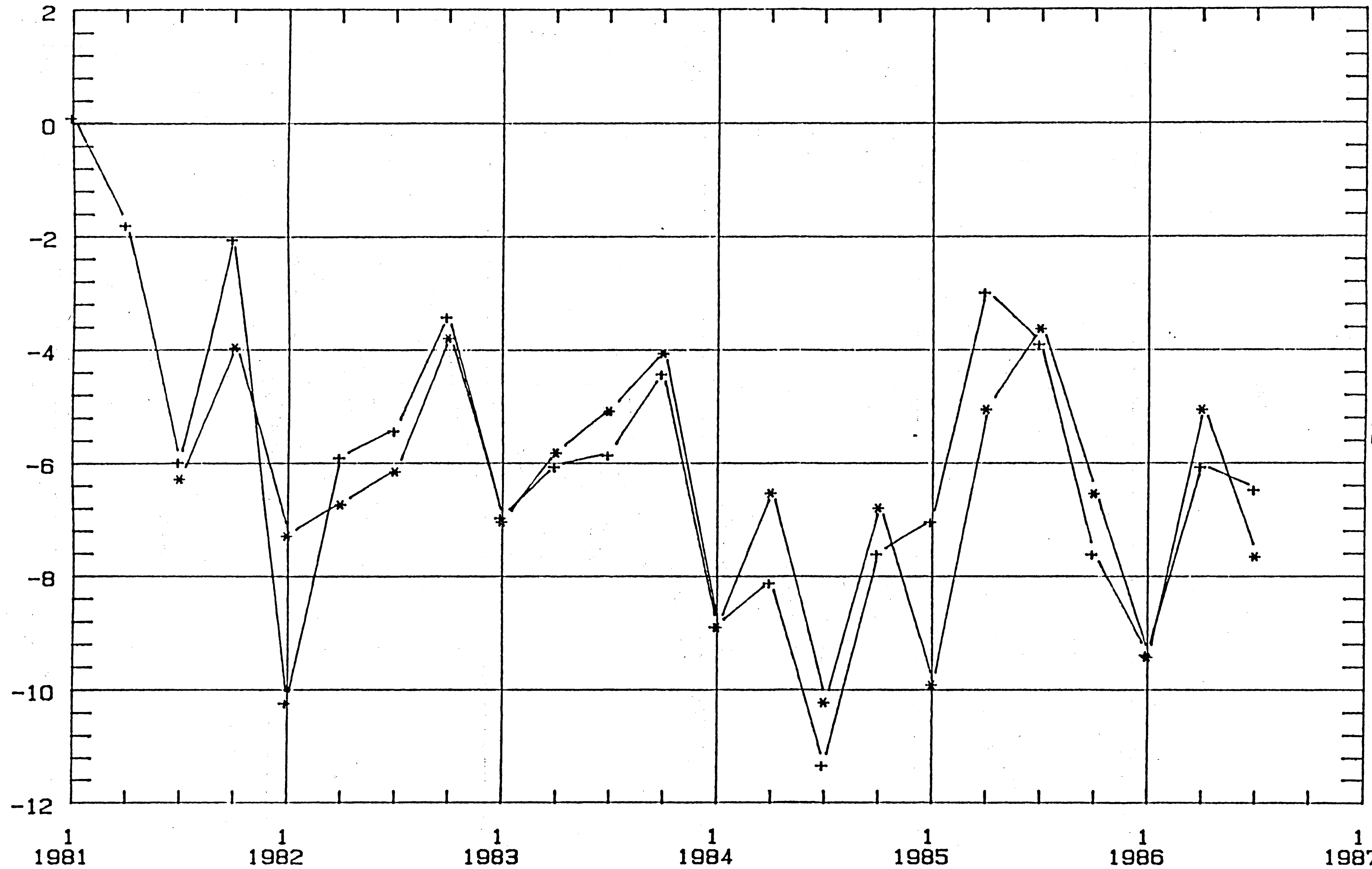


FIGURE C.2: ACTUAL (PDSS14) AND FITTED (PDSS14F) VALUES FOR CALGARY-U.S. SLAUGHTER STEER PRICE SPREAD (C$/CWT.).



SYMBOL		SCALE	VARIABLE
———	+	(-12, 2)	PDSS14
———	*	(-12, 2)	PDSS14F

FIGURE C.3: ACTUAL(PDSS21) AND FITTED(PDSS21F) VALUES FOR TORONTO-CALGARY SLAUGHTER STEER PRICE SPREAD (C$/CWT.).

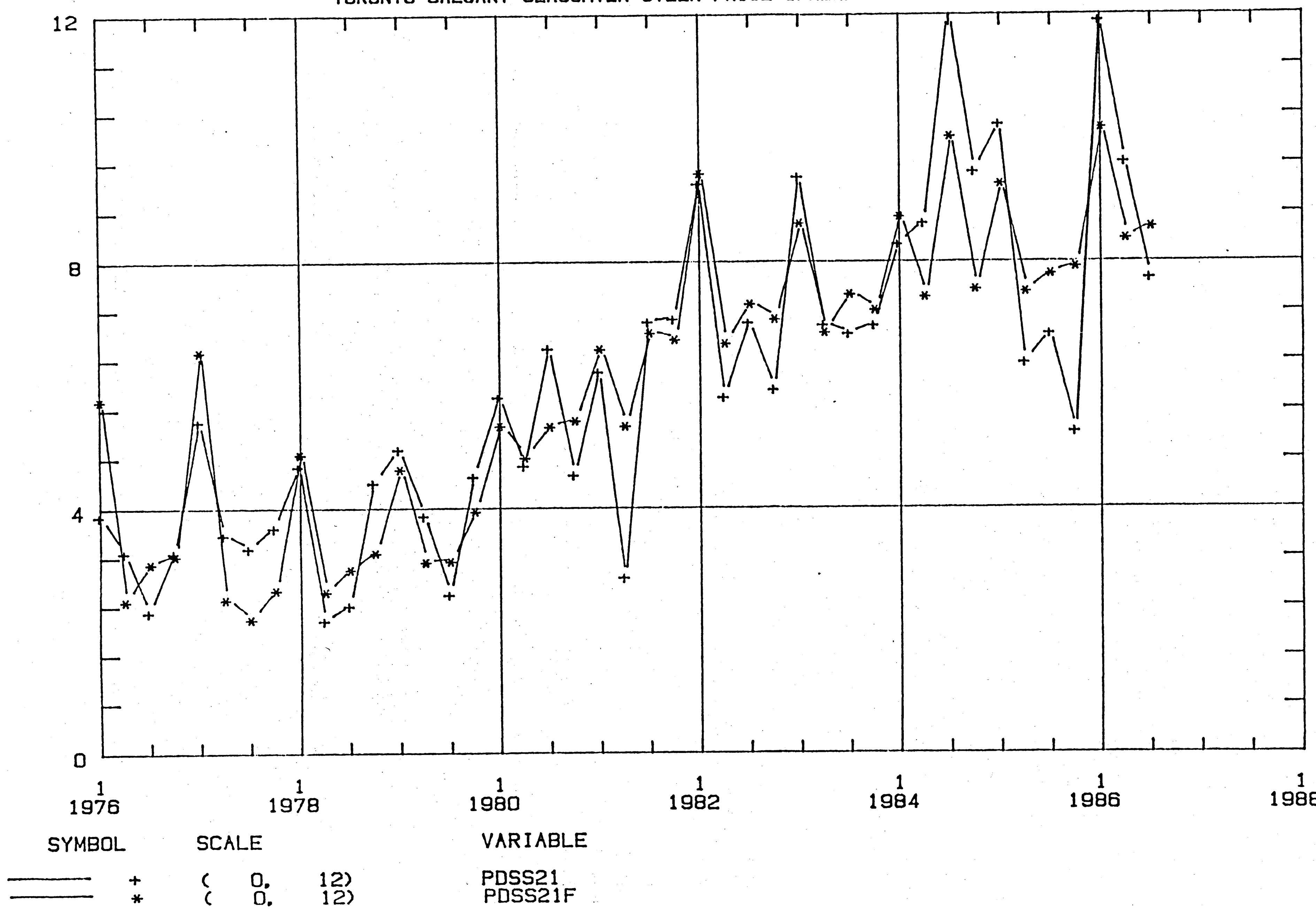


FIGURE C.4: ACTUAL (PDBW24) AND FITTED (PDBW24F) VALUES FOR TORONTO-U.S. SLAUGHTER COW PRICE SPREAD (C$/CWT.).

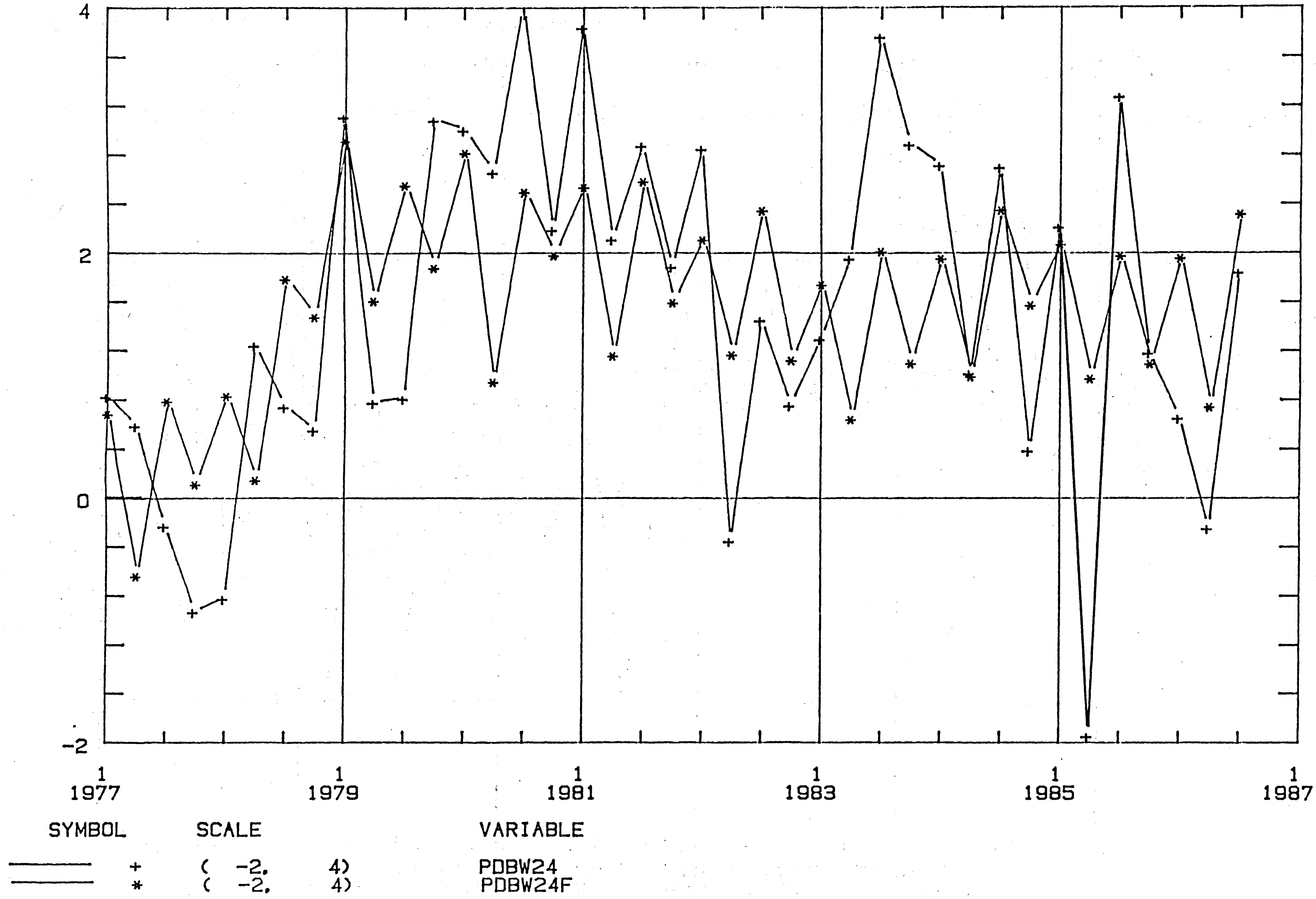
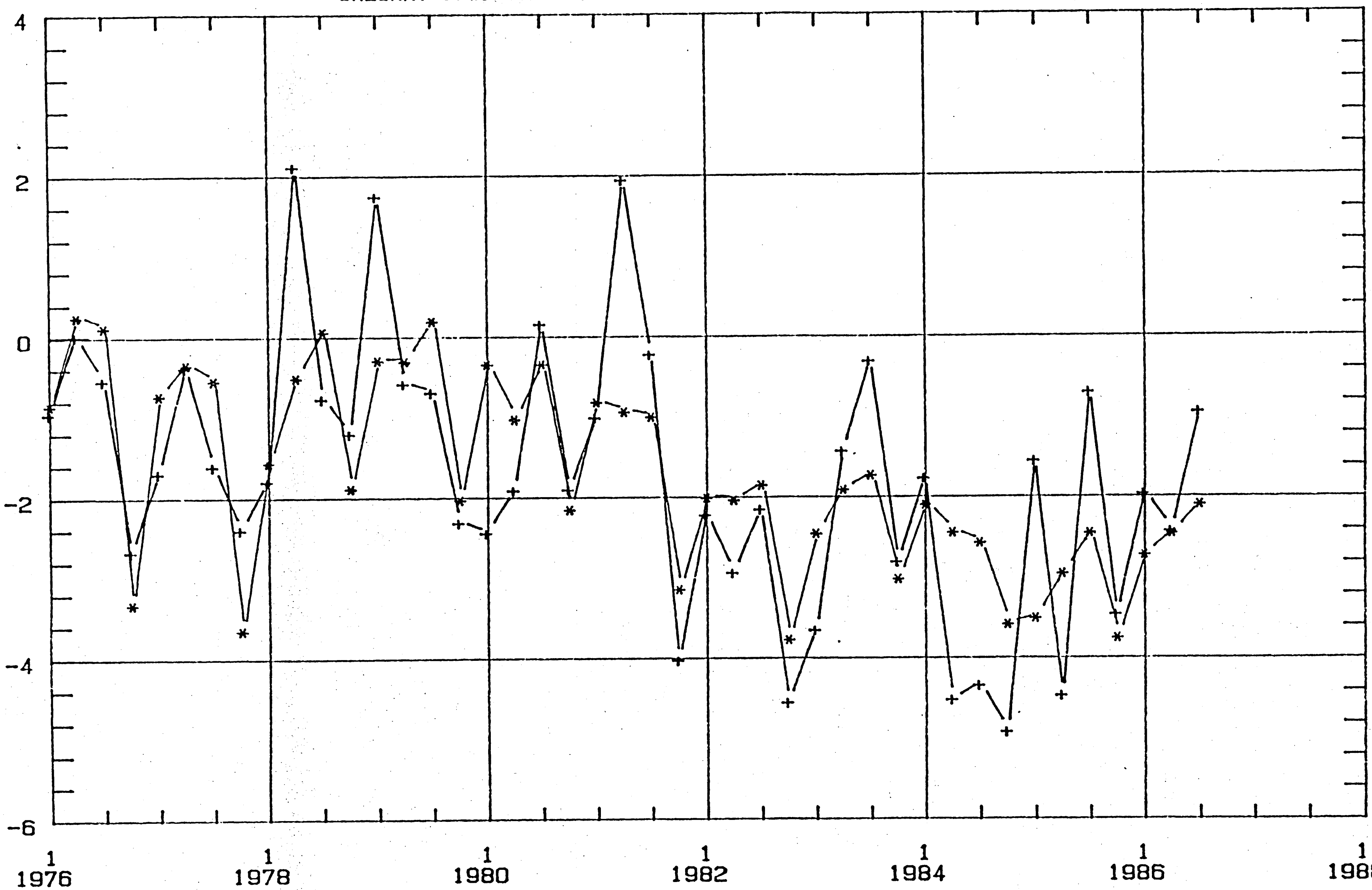


FIGURE C.5: ACTUAL (PDBW14) AND FITTED (PDBW14F) VALUES FOR CALGARY-U.S. SLAUGHTER COW PRICE SPREAD (C$/CWT.).



SYMBOL		SCALE	VARIABLE
———	+	(-6, 4)	PDBW14
———	*	(-6, 4)	PDBW14F

FIGURE C.6: ACTUAL (PDFC14) AND FITTED (PDFC14F) VALUES FOR CALGARY-U.S. FEEDER CALF PRICE SPREAD (C$/CWT.).

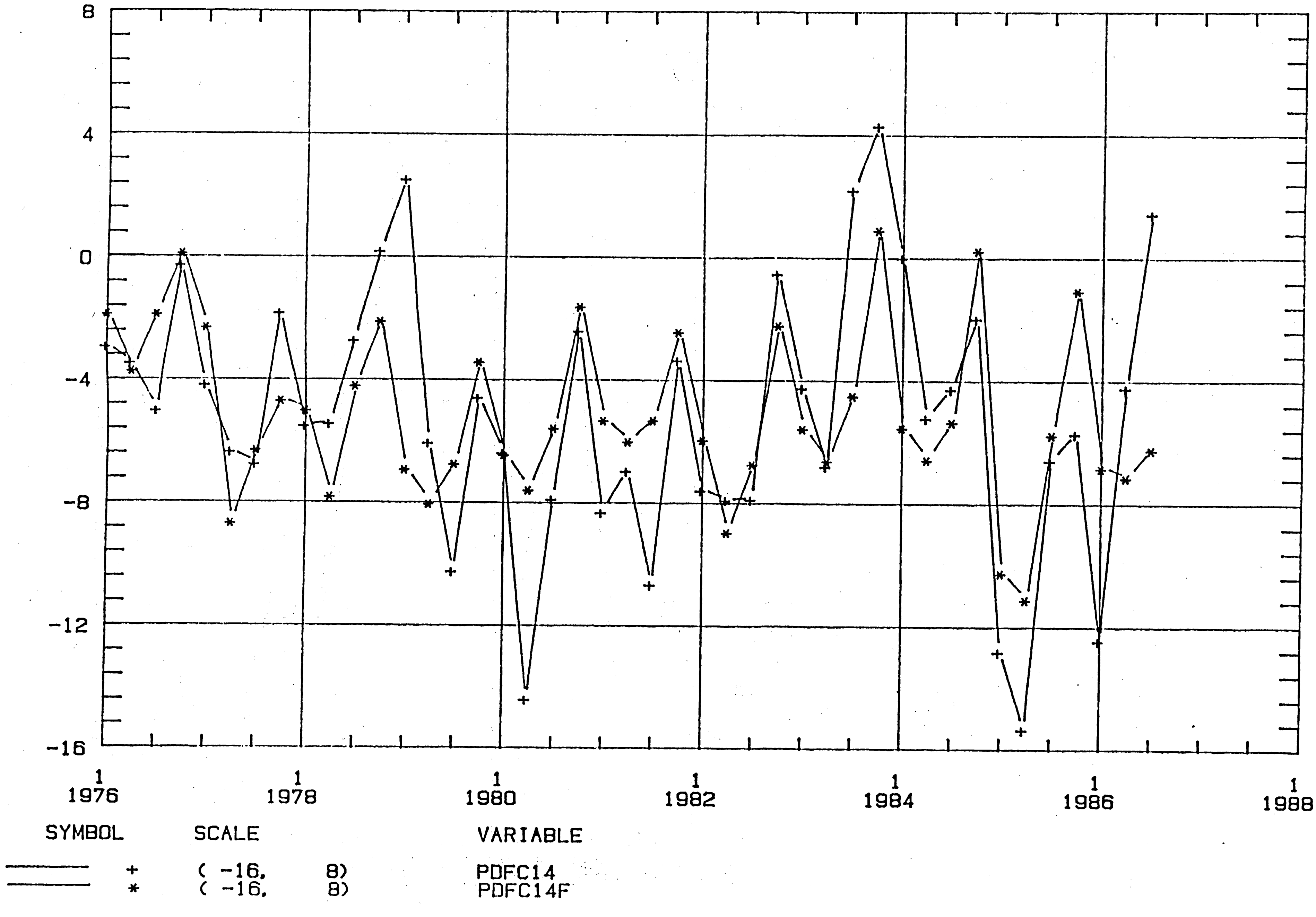
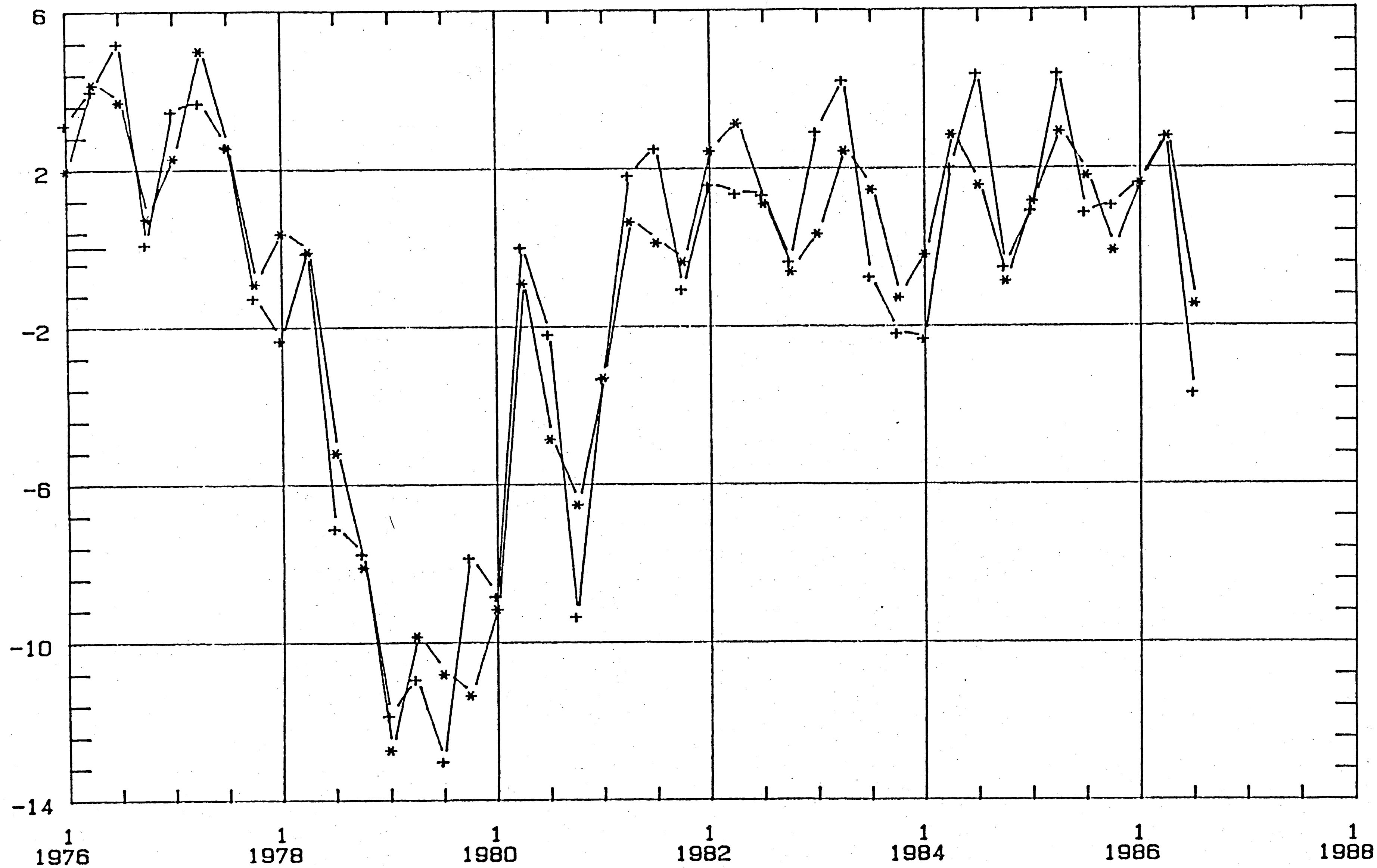


FIGURE C.7: ACTUAL (PDFC21) AND FITTED (PDFC21F) VALUES FOR TORONTO-CALGARY FEEDER CALF PRICE SPREAD (C$/CCWT.).



SYMBOL		SCALE	VARIABLE
———	+	(-14, 6)	PDFC21
———	*	(-14, 6)	PDFC21F

FIGURE C.8: ACTUAL (PDHG24) AND FITTED (PDHG24F) VALUES FOR TORONTO-U.S. HOG PRICE SPREAD (C$/CWT.).

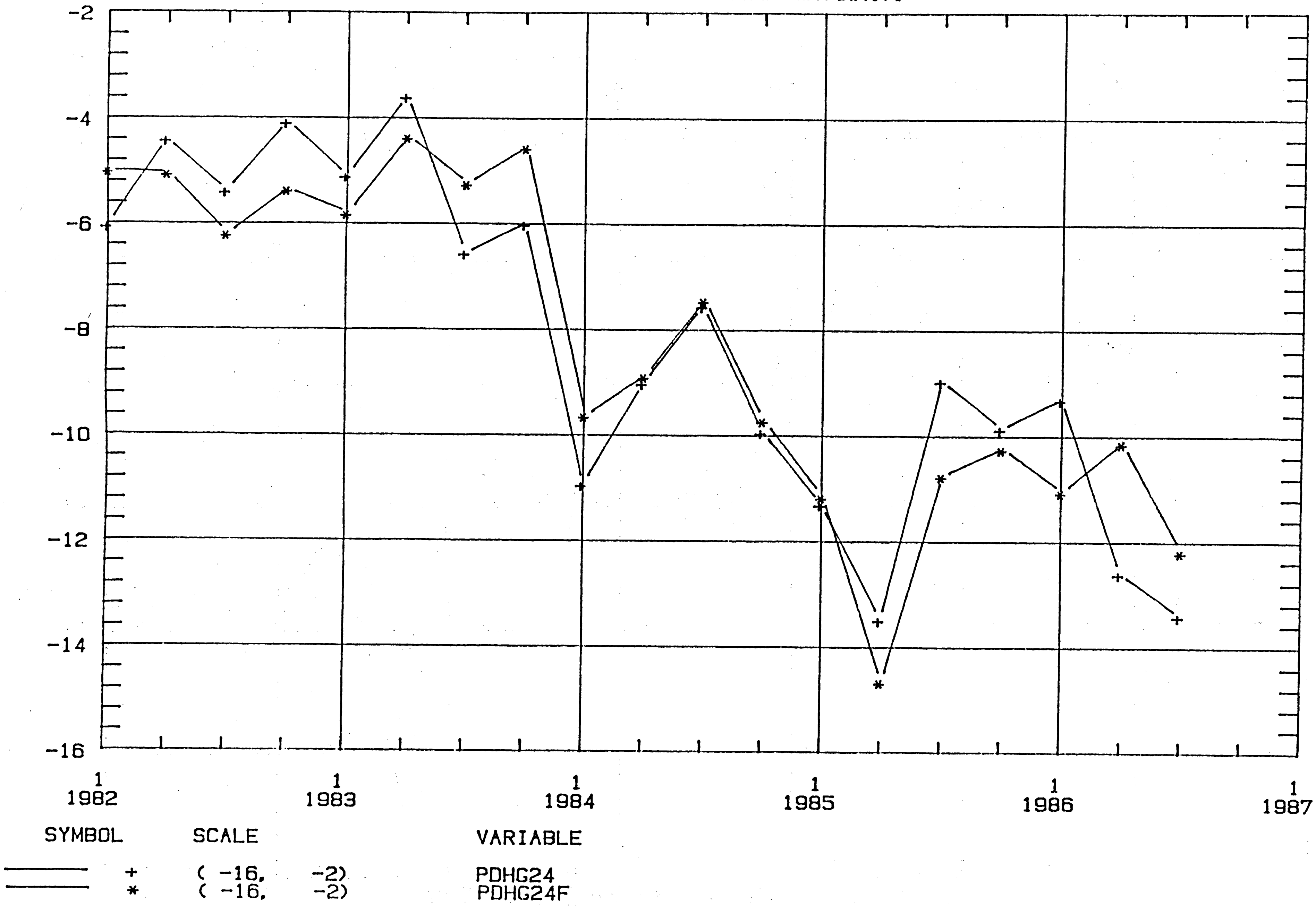
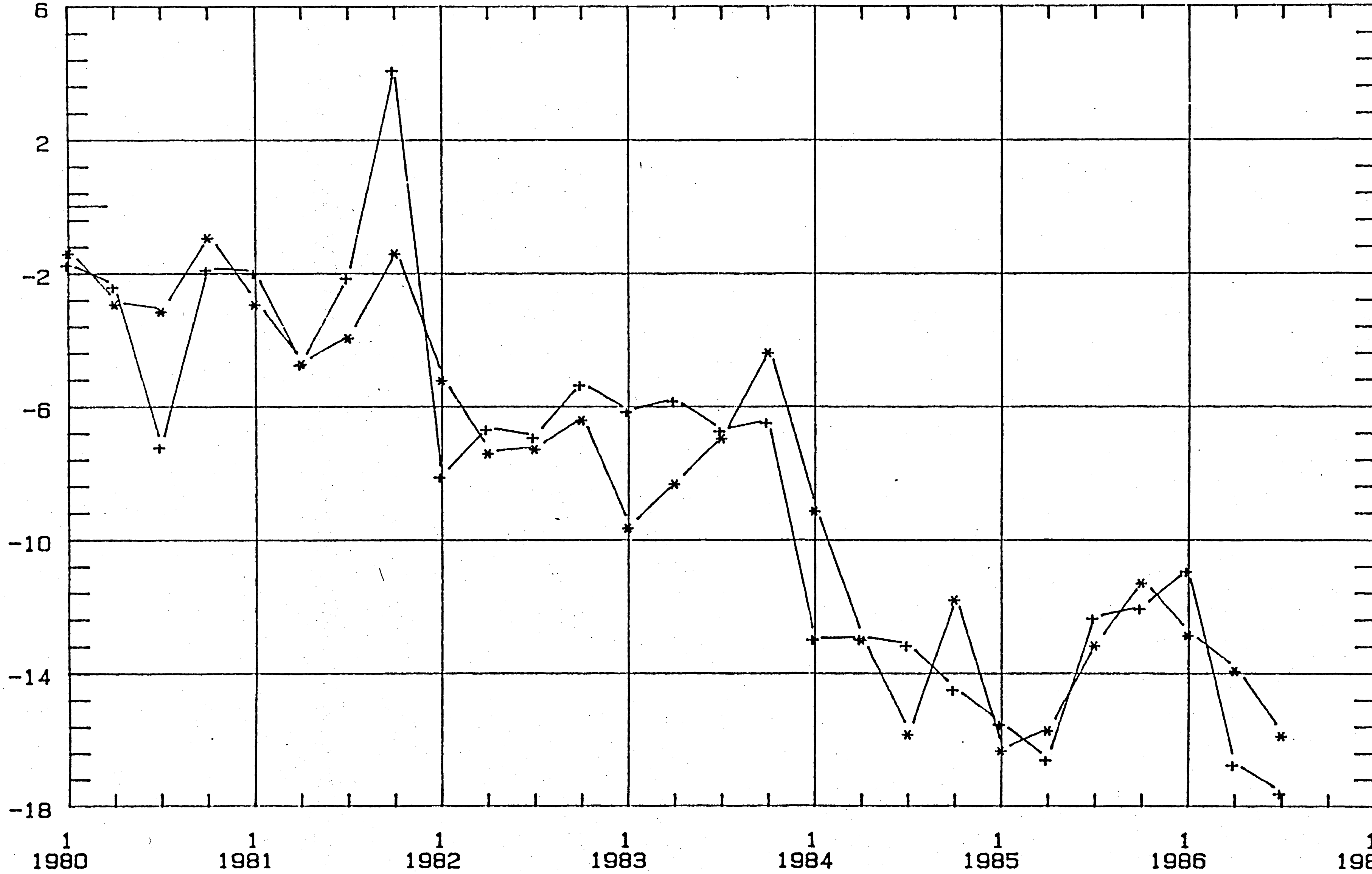


FIGURE C.9: ACTUAL (PDHG14) AND FITTED (PDHG14F) VALUES FOR EDMONTON-U.S. HOG PRICE SPREAD (C$/CWT.).



SYMBOL	SCALE	VARIABLE
+	(-18, 6)	PDHG14
*	(-18, 6)	PDHG14F

FIGURE C.10: ACTUAL (PDHG21) AND FITTED (PDHG21F) VALUES FOR TORONTO-EDMONTON HOG PRICE SPREAD (C$/CWT.).

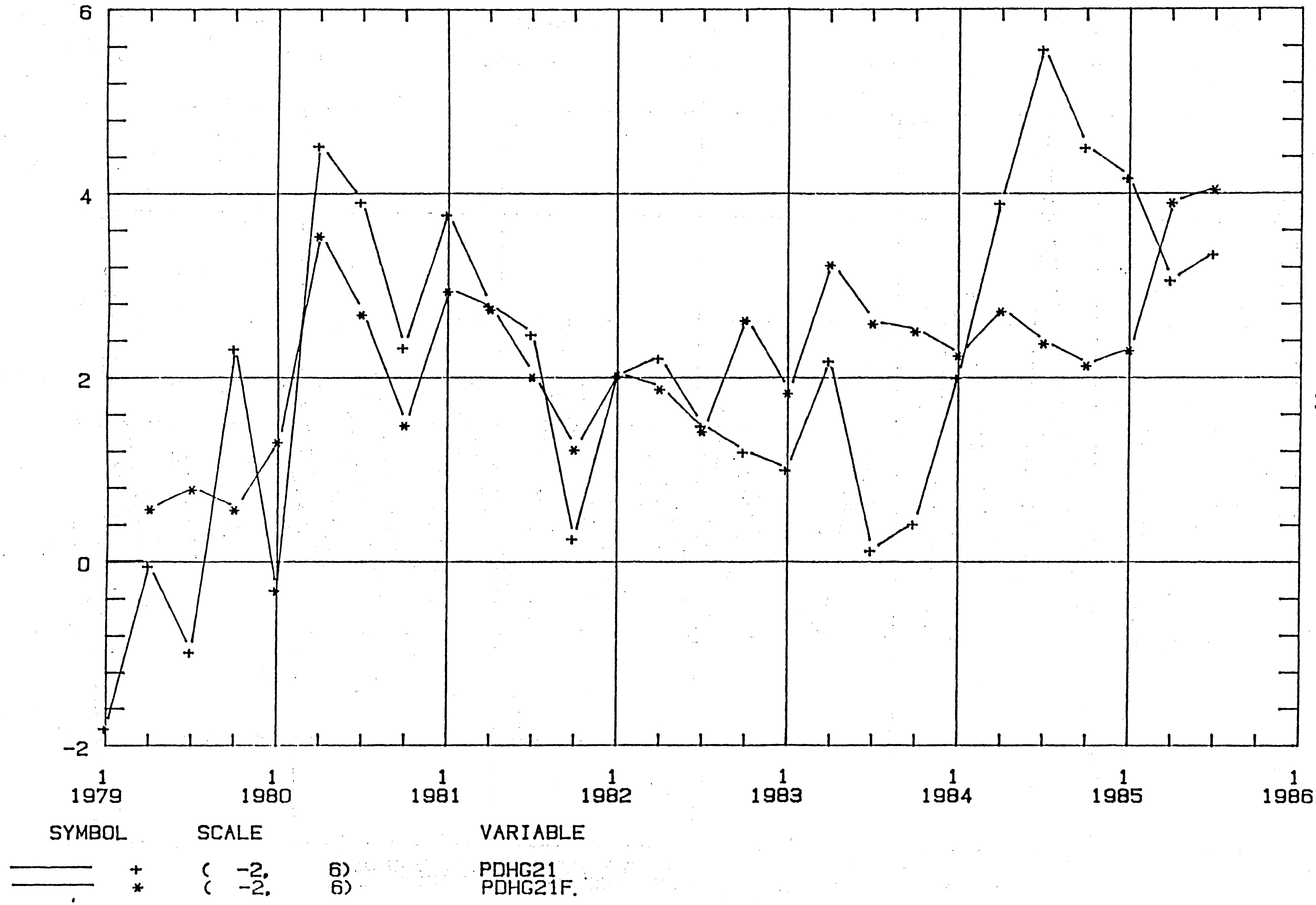
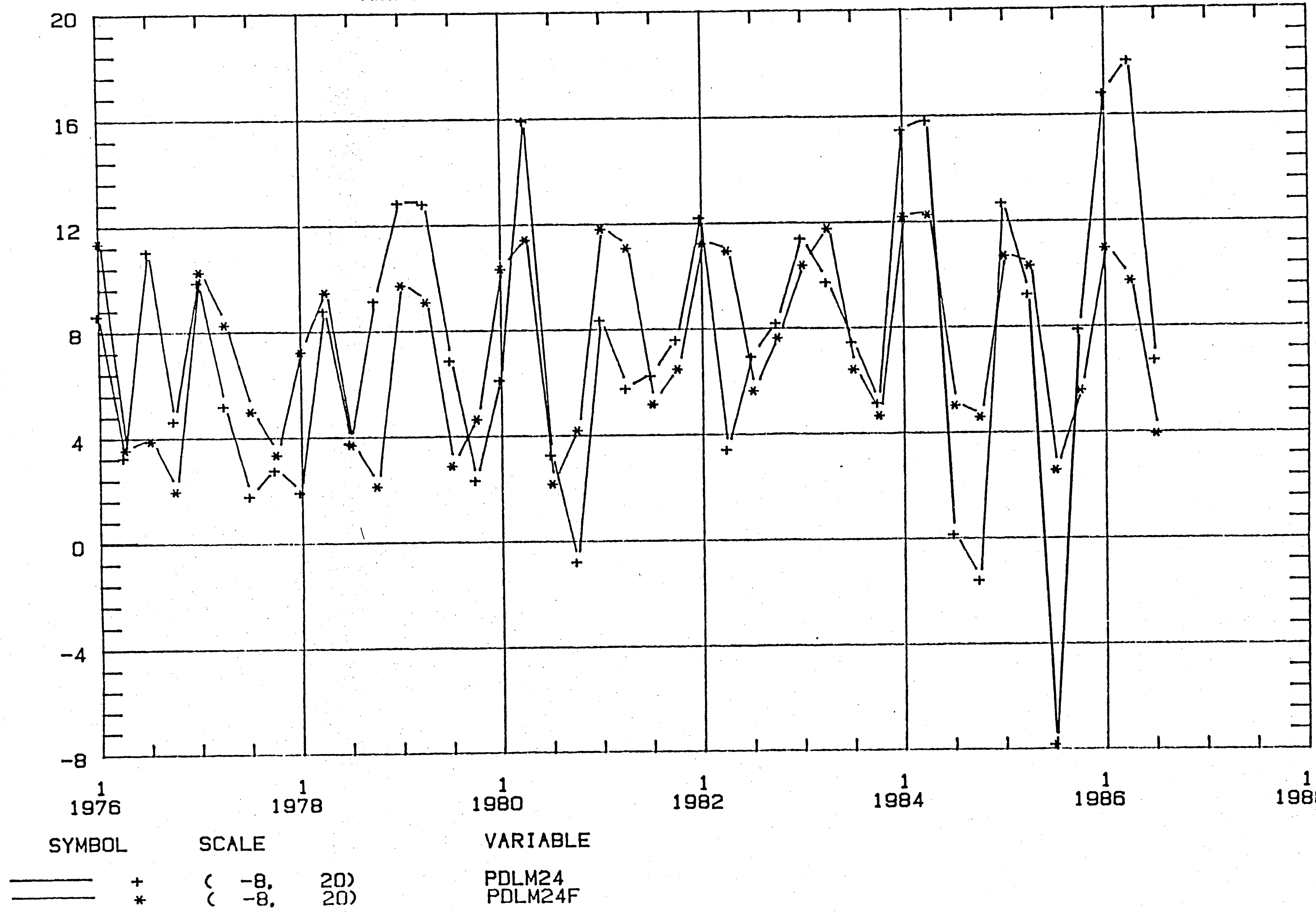


FIGURE C.11: ACTUAL(PDLM24) AND FITTED(PDLM24F) VALUES FOR TORONTO-U.S. SLAUGHTER LAMB PRICE SPREAD (C$/CWT.).



A N N E X

to

An Analysis of Spatial Price Differences in the North-American Livestock Sector

by

Giancarlo Moschini
and
Karl D. Meilke

for

Agriculture Canada
Policy Branch
(Research Contract PB-015/86)

March 1987

Content

Table N1 - Western Canada Beef Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	0.3	4.4	4.7	20.8	0.1	20.9	20.5	-4.3	16.2
1967	0.9	7.0	7.9	6.9	0.1	7.0	6.0	-7.0	-1.0
1968	0.4	6.2	6.6	11.2	0.1	11.3	10.9	-6.1	4.7
1969	1.1	38.1	39.2	7.6	0.0	7.6	6.5	-38.0	-31.6
1970	1.2	36.6	37.8	17.2	0.1	17.3	16.0	-36.6	-20.5
1971	1.9	28.3	30.2	12.8	0.2	13.0	10.9	-28.1	-17.2
1972	3.3	27.2	30.5	5.5	0.1	5.6	2.1	-27.1	-24.9
1973	5.6	22.8	28.3	7.7	1.5	9.2	2.1	-21.3	-19.1
1974	4.2	22.5	26.7	6.4	0.4	6.9	2.2	-22.0	-19.8
1975	2.5	29.1	31.6	2.3	1.7	4.1	-0.1	-27.4	-27.5
1976	2.7	48.8	51.5	27.9	3.1	30.9	25.2	-45.7	-20.6
1977	1.3	29.2	30.6	26.2	3.0	29.2	24.9	-26.2	-1.3
1978	1.4	25.3	26.7	23.8	3.2	27.0	22.4	-22.1	0.2
1979	1.0	20.4	21.5	22.7	3.2	25.9	21.6	-17.2	4.5
1980	3.0	22.9	25.8	20.5	3.8	24.3	17.5	-19.1	-1.6
1981	6.6	20.6	27.2	40.0	4.0	44.0	33.4	-16.6	16.8
1982	4.3	23.0	27.2	50.1	4.2	54.2	45.8	-18.8	27.0
1983	5.1	18.8	23.9	56.1	5.7	61.8	51.0	-13.1	37.9
1984	14.2	19.5	33.7	74.4	5.6	80.0	60.2	-13.9	46.3
1985	13.8	23.3	37.1	112.7	6.0	118.7	98.9	-17.3	81.6
	relative distribution								
1966	0.06	0.94		1.00	0.00				
1967	0.11	0.89		0.99	0.01				
1968	0.05	0.95		0.99	0.01				
1969	0.03	0.97		0.99	0.01				
1970	0.03	0.97		1.00	0.00				
1971	0.06	0.94		0.99	0.01				
1972	0.11	0.89		0.98	0.02				
1973	0.20	0.80		0.84	0.16				
1974	0.16	0.84		0.94	0.06				
1975	0.08	0.92		0.57	0.43				
1976	0.05	0.95		0.90	0.10				
1977	0.04	0.96		0.90	0.10				
1978	0.05	0.95		0.88	0.12				
1979	0.05	0.95		0.87	0.13				
1980	0.12	0.88		0.84	0.16				
1981	0.24	0.76		0.91	0.09				
1982	0.16	0.84		0.92	0.08				
1983	0.21	0.79		0.91	0.09				
1984	0.42	0.58		0.93	0.07				
1985	0.37	0.63		0.95	0.05				

Source: Agriculture Canada databank.

Table N2 - Eastern Canada Beef Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	20.1	22.6	42.7	36.8	7.2	44.0	16.7	-15.4	1.3
1967	26.5	34.9	61.3	24.5	5.0	29.5	-1.9	-29.9	-31.8
1968	19.5	35.7	55.2	46.5	6.7	53.2	27.0	-29.0	-2.0
1969	16.2	131.8	147.9	63.7	6.3	70.0	47.5	-125.5	-77.9
1970	17.7	162.7	180.5	113.2	8.6	121.8	95.5	-154.1	-58.7
1971	32.9	107.2	140.0	86.5	8.2	94.6	53.6	-99.0	-45.4
1972	41.9	132.8	174.7	70.3	11.4	81.7	28.4	-121.3	-93.0
1973	45.5	149.1	194.5	75.0	10.5	85.6	29.6	-138.5	-109.0
1974	20.8	131.7	152.5	52.5	7.2	59.8	31.7	-124.4	-92.7
1975	11.6	151.5	163.0	37.0	10.0	47.0	25.5	-141.5	-116.0
1976	28.1	232.8	260.9	85.5	13.0	98.5	57.4	-219.8	-162.4
1977	14.5	147.2	161.7	73.0	10.1	83.1	58.6	-137.1	-78.6
1978	15.5	172.8	188.3	57.9	13.5	71.4	42.4	-159.3	-117.0
1979	8.6	153.5	162.1	76.2	12.6	88.8	67.6	-140.9	-73.3
1980	11.3	135.4	146.8	103.0	16.2	119.2	91.7	-119.2	-27.5
1981	18.8	128.4	147.2	113.8	17.8	131.6	95.0	-110.6	-15.6
1982	21.5	142.5	164.0	112.5	16.7	129.3	91.0	-125.8	-34.8
1983	26.0	150.8	176.9	108.0	12.8	120.7	81.9	-138.1	-56.2
1984	42.6	178.0	220.6	139.8	14.5	154.3	97.2	-163.5	-66.3
1985	43.7	172.0	215.7	128.4	11.8	140.3	84.8	-160.2	-75.4
	relative distribution								
1966	0.47	0.53		0.84	0.16				
1967	0.43	0.57		0.83	0.17				
1968	0.35	0.65		0.87	0.13				
1969	0.11	0.89		0.91	0.09				
1970	0.10	0.90		0.93	0.07				
1971	0.23	0.77		0.91	0.09				
1972	0.24	0.76		0.86	0.14				
1973	0.23	0.77		0.88	0.12				
1974	0.14	0.86		0.88	0.12				
1975	0.07	0.93		0.79	0.21				
1976	0.11	0.89		0.87	0.13				
1977	0.09	0.91		0.88	0.12				
1978	0.08	0.92		0.81	0.19				
1979	0.05	0.95		0.86	0.14				
1980	0.08	0.92		0.86	0.14				
1981	0.13	0.87		0.86	0.14				
1982	0.13	0.87		0.87	0.13				
1983	0.15	0.85		0.89	0.11				
1984	0.19	0.81		0.91	0.09				
1985	0.20	0.80		0.92	0.08				

Source: Agriculture Canada databank.

Table N3 - Canada Beef Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	20.3	27.0	47.4	57.6	7.3	64.9	37.2	-19.7	17.5
1967	27.4	41.9	69.3	31.4	5.0	36.5	4.1	-36.9	-32.8
1968	19.9	41.9	61.8	57.7	6.8	64.5	37.8	-35.1	2.7
1969	17.3	169.8	187.1	71.3	6.3	77.6	54.0	-163.5	-109.5
1970	18.9	199.4	218.3	130.4	8.7	139.1	111.5	-190.7	-79.2
1971	34.7	135.5	170.2	99.2	8.4	107.6	64.5	-127.1	-62.6
1972	45.3	159.9	205.2	75.8	11.5	87.3	30.5	-148.4	-117.9
1973	51.0	171.8	222.8	82.7	12.1	94.7	31.7	-159.8	-128.1
1974	25.0	154.1	179.1	58.9	7.7	66.6	34.0	-146.5	-112.5
1975	14.0	180.6	194.6	39.3	11.7	51.1	25.3	-168.9	-143.5
1976	30.8	281.6	312.5	113.4	16.1	129.5	82.6	-265.6	-183.0
1977	15.8	176.4	192.2	99.2	13.1	112.3	83.4	-163.3	-79.9
1978	17.0	198.1	215.1	81.7	16.7	98.3	64.7	-181.5	-116.7
1979	9.6	173.9	183.5	98.9	15.8	114.7	89.3	-158.1	-68.8
1980	14.3	158.3	172.6	123.5	20.0	143.5	109.2	-138.3	-29.1
1981	25.4	149.0	174.4	153.7	21.8	175.5	128.3	-127.2	1.2
1982	25.7	165.5	191.3	162.6	20.9	183.5	136.8	-144.6	-7.8
1983	31.1	169.6	200.7	164.0	18.5	182.5	132.9	-151.2	-18.2
1984	56.9	197.5	254.3	214.2	20.0	234.3	157.4	-177.4	-20.1
1985	57.5	195.3	252.8	241.2	17.8	259.0	183.7	-177.5	6.2
	relative distribution								
1966	0.43	0.57		0.89	0.11				
1967	0.40	0.60		0.86	0.14				
1968	0.32	0.68		0.90	0.10				
1969	0.09	0.91		0.92	0.08				
1970	0.09	0.91		0.94	0.06				
1971	0.20	0.80		0.92	0.08				
1972	0.22	0.78		0.87	0.13				
1973	0.23	0.77		0.87	0.13				
1974	0.14	0.86		0.88	0.12				
1975	0.07	0.93		0.77	0.23				
1976	0.10	0.90		0.88	0.12				
1977	0.08	0.92		0.88	0.12				
1978	0.08	0.92		0.83	0.17				
1979	0.05	0.95		0.86	0.14				
1980	0.08	0.92		0.86	0.14				
1981	0.15	0.85		0.88	0.12				
1982	0.13	0.87		0.89	0.11				
1983	0.15	0.85		0.90	0.10				
1984	0.22	0.78		0.91	0.09				
1985	0.23	0.77		0.93	0.07				

Source: Agriculture Canada databank.

Table N4 - Western Canada Pork Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	7.2	0.9	8.0	21.7	1.3	23.0	14.5	0.4	15.0
1967	5.2	0.0	5.2	28.6	1.2	29.8	23.4	1.2	24.6
1968	8.6	1.2	9.8	31.4	1.7	33.1	22.7	0.5	23.2
1969	13.2	2.2	15.4	27.6	3.6	31.2	14.4	1.4	15.8
1970	3.0	3.0	6.0	38.8	7.3	46.1	35.8	4.3	40.1
1971	0.5	3.6	4.1	49.9	21.5	71.3	49.4	17.8	67.2
1972	5.6	3.1	8.7	43.1	39.5	82.5	37.4	36.4	73.9
1973	9.5	2.7	12.3	45.3	35.4	80.7	35.8	32.7	68.5
1974	19.0	1.0	19.9	32.6	26.5	59.1	13.6	25.6	39.2
1975	30.0	0.7	30.8	13.7	31.5	45.2	-16.3	30.8	14.5
1976	77.9	1.2	79.1	10.5	30.8	41.3	-67.5	29.7	-37.8
1977	86.3	1.2	87.5	8.0	31.6	39.7	-78.3	30.4	-47.9
1978	49.6	2.2	51.8	9.1	19.3	28.4	-40.5	17.1	-23.4
1979	26.3	1.7	28.0	9.4	20.7	30.0	-16.9	18.9	2.0
1980	9.4	0.6	10.0	17.9	17.6	35.5	8.5	17.1	25.5
1981	8.7	1.9	10.6	19.0	17.3	36.4	10.3	15.5	25.8
1982	4.3	1.3	5.6	29.7	18.4	48.1	25.4	17.1	42.5
1983	4.8	2.0	6.8	31.5	17.5	49.1	26.7	15.5	42.2
1984	1.9	4.2	6.2	71.4	18.1	89.5	69.4	13.9	83.3
1985	1.2	4.6	5.7	115.5	13.9	129.3	114.3	9.3	123.6
	relative distribution								
1966	0.89	0.11		0.94	0.06				
1967	1.00	0.00		0.96	0.04				
1968	0.88	0.12		0.95	0.05				
1969	0.86	0.14		0.88	0.12				
1970	0.50	0.50		0.84	0.16				
1971	0.11	0.89		0.70	0.30				
1972	0.65	0.35		0.52	0.48				
1973	0.78	0.22		0.56	0.44				
1974	0.95	0.05		0.55	0.45				
1975	0.98	0.02		0.30	0.70				
1976	0.99	0.01		0.25	0.75				
1977	0.99	0.01		0.20	0.80				
1978	0.96	0.04		0.32	0.68				
1979	0.94	0.06		0.31	0.69				
1980	0.94	0.06		0.50	0.50				
1981	0.82	0.18		0.52	0.48				
1982	0.77	0.23		0.62	0.38				
1983	0.70	0.30		0.64	0.36				
1984	0.31	0.69		0.80	0.20				
1985	0.20	0.80		0.89	0.11				

Source: Agriculture Canada databank.

Table N5 - Eastern Canada Pork Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	21.3	8.3	29.6	25.1	4.8	29.9	3.8	-3.4	0.4
1967	22.8	1.0	23.8	26.6	6.0	32.6	3.8	5.0	8.8
1968	29.0	10.4	39.4	25.1	5.9	31.0	-3.9	-4.5	-8.5
1969	55.0	9.1	64.1	23.0	5.0	28.0	-32.0	-4.2	-36.2
1970	20.9	7.1	28.0	22.1	5.0	27.1	1.2	-2.1	-0.9
1971	14.2	9.0	23.2	19.0	9.4	28.4	4.9	0.3	5.2
1972	29.0	7.6	36.5	19.2	14.2	33.4	-9.8	6.6	-3.1
1973	33.3	8.7	42.0	23.2	22.1	45.3	-10.1	13.4	3.2
1974	44.3	5.9	50.2	16.0	18.2	34.1	-28.3	12.3	-16.0
1975	63.4	4.2	67.7	17.1	28.9	45.9	-46.4	24.6	-21.8
1976	114.3	3.6	117.9	12.1	34.3	46.4	-102.2	30.7	-71.6
1977	112.5	2.4	114.8	14.8	47.6	62.5	-97.6	45.3	-52.4
1978	64.9	3.1	68.0	38.5	57.9	96.4	-26.4	54.8	28.4
1979	42.6	3.3	45.9	80.3	65.4	145.7	37.7	62.1	99.8
1980	27.4	1.4	28.7	152.3	72.4	224.7	124.9	71.0	195.9
1981	30.8	2.3	33.1	155.5	92.7	248.2	124.7	90.4	215.1
1982	24.9	1.8	26.8	219.5	93.2	312.7	194.6	91.4	285.9
1983	28.7	7.5	36.2	212.0	86.6	298.6	183.2	79.2	262.4
1984	16.7	10.2	26.8	242.9	54.6	297.5	226.2	44.4	270.6
1985	12.3	20.1	32.4	259.2	45.2	304.4	246.9	25.1	272.0
	relative distribution								
1966	0.72	0.28		0.84	0.16				
1967	0.96	0.04		0.82	0.18				
1968	0.74	0.26		0.81	0.19				
1969	0.86	0.14		0.82	0.18				
1970	0.75	0.25		0.82	0.18				
1971	0.61	0.39		0.67	0.33				
1972	0.79	0.21		0.58	0.42				
1973	0.79	0.21		0.51	0.49				
1974	0.88	0.12		0.47	0.53				
1975	0.94	0.06		0.37	0.63				
1976	0.97	0.03		0.26	0.74				
1977	0.98	0.02		0.24	0.76				
1978	0.95	0.05		0.40	0.60				
1979	0.93	0.07		0.55	0.45				
1980	0.95	0.05		0.68	0.32				
1981	0.93	0.07		0.63	0.37				
1982	0.93	0.07		0.70	0.30				
1983	0.79	0.21		0.71	0.29				
1984	0.62	0.38		0.82	0.18				
1985	0.38	0.62		0.85	0.15				

Source: Agriculture Canada databank.

Table N6 - Canada pork Trade with U.S. and R.O.W.
millions of pounds in carcass weight

	Imports			Exports			Net Exports		
	from US	from ROW	total	to US	to ROW	total	to US	to ROW	total
1966	28.5	9.1	37.6	46.8	6.2	53.0	18.3	-3.0	15.3
1967	28.0	1.0	29.0	55.2	7.2	62.4	27.2	6.2	33.4
1968	37.6	11.6	49.3	56.4	7.6	64.0	18.8	-4.0	14.8
1969	68.2	11.3	79.5	50.6	8.6	59.2	-17.6	-2.8	-20.4
1970	23.9	10.1	34.0	60.9	12.3	73.2	37.0	2.2	39.3
1971	14.6	12.7	27.3	68.9	30.8	99.7	54.3	18.2	72.4
1972	34.6	10.6	45.2	62.3	53.7	116.0	27.7	43.1	70.8
1973	42.9	11.4	54.3	68.5	57.5	126.0	25.6	46.1	71.7
1974	63.2	6.9	70.1	48.6	44.7	93.2	-14.7	37.8	23.2
1975	93.5	5.0	98.4	30.8	60.4	91.1	-62.7	55.4	-7.3
1976	192.2	4.8	197.0	22.6	65.1	87.7	-169.7	60.3	-109.3
1977	198.8	3.6	202.4	22.8	79.3	102.1	-176.0	75.7	-100.3
1978	114.5	5.3	119.8	47.5	77.3	124.8	-67.0	72.0	5.0
1979	68.9	5.0	73.9	89.7	86.1	175.7	20.8	81.0	101.8
1980	36.8	1.9	38.7	170.2	90.0	260.2	133.4	88.1	221.5
1981	39.5	4.2	43.7	174.6	110.0	284.6	135.0	105.8	240.9
1982	29.3	3.1	32.4	249.2	111.6	360.8	219.9	108.5	328.4
1983	33.6	9.5	43.1	243.5	104.2	347.7	210.0	94.7	304.6
1984	18.6	14.4	33.0	314.3	72.7	387.0	295.7	58.3	354.0
1985	13.4	24.7	38.1	374.7	59.1	433.7	361.2	34.4	395.6
	relative distribution								
1966	0.76	0.24		0.88	0.12				
1967	0.96	0.04		0.88	0.12				
1968	0.76	0.24		0.88	0.12				
1969	0.86	0.14		0.86	0.14				
1970	0.70	0.30		0.83	0.17				
1971	0.54	0.46		0.69	0.31				
1972	0.77	0.23		0.54	0.46				
1973	0.79	0.21		0.54	0.46				
1974	0.90	0.10		0.52	0.48				
1975	0.95	0.05		0.34	0.66				
1976	0.98	0.02		0.26	0.74				
1977	0.98	0.02		0.22	0.78				
1978	0.96	0.04		0.38	0.62				
1979	0.93	0.07		0.51	0.49				
1980	0.95	0.05		0.65	0.35				
1981	0.90	0.10		0.61	0.39				
1982	0.90	0.10		0.69	0.31				
1983	0.78	0.22		0.70	0.30				
1984	0.56	0.44		0.81	0.19				
1985	0.35	0.65		0.86	0.14				

Source: Agriculture Canada databank.

Table N7 - Composition of Canada Beef Imports from the U.S.

	Western Canada				Eastern Canada			
	relative proportion of			total (mill lbs)	relative proportion of			total (mill lbs)
	fresh & frozen	cured	canned		fresh & frozen	cured	canned	
1967	0.66	0.33	0.01	0.9	0.32	0.68	0.00	26.5
1968	0.80	0.16	0.04	0.4	0.21	0.79	0.00	19.5
1969	0.86	0.13	0.01	1.1	0.29	0.71	0.00	16.2
1970	0.97	0.03	0.00	1.2	0.35	0.65	0.01	17.7
1971	0.87	0.12	0.01	1.9	0.57	0.43	0.00	32.9
1972	0.82	0.18	0.00	3.3	0.69	0.31	0.00	41.9
1973	0.94	0.06	0.00	5.6	0.80	0.20	0.00	45.5
1974	0.97	0.03	0.00	4.2	0.88	0.12	0.00	20.8
1975	1.00	0.00	0.00	2.5	0.99	0.01	0.00	11.6
1976	0.96	0.04	0.00	2.7	0.98	0.02	0.00	28.1
1977	0.81	0.18	0.01	1.3	0.96	0.04	0.00	14.5
1978	0.70	0.30	0.00	1.4	0.96	0.04	0.00	15.5
1979	0.76	0.24	0.00	1.0	0.97	0.03	0.00	8.6
1980	0.89	0.10	0.01	3.0	0.97	0.03	0.00	11.3
1981	0.92	0.08	0.00	6.6	0.97	0.03	0.00	18.8
1982	0.84	0.16	0.00	4.3	0.98	0.02	0.00	21.5
1983	0.90	0.10	0.00	5.1	0.98	0.02	0.00	26.0
1984	0.97	0.03	0.00	14.2	0.99	0.01	0.00	42.6
1985	0.96	0.04	0.00	13.8	0.99	0.01	0.00	43.7

Source : Agriculture Canada databank.

Table N8 - Composition of Canada Beef Exports to the U.S.

	Western Canada			Eastern Canada		
	relative proportion		total (mill lbs)	relative proportion		total (mill lbs)
	fresh & frozen	cured		fresh & frozen	cured	
1967	0.96	0.04	6.9	0.99	0.01	24.5
1968	0.97	0.03	11.2	0.99	0.01	46.5
1969	0.94	0.06	7.6	0.99	0.01	63.7
1970	0.97	0.03	17.2	0.99	0.01	113.2
1971	0.97	0.03	12.8	0.99	0.01	86.5
1972	0.90	0.10	5.5	0.98	0.02	70.3
1973	0.89	0.11	7.7	0.99	0.01	75.0
1974	0.86	0.14	6.4	0.98	0.02	52.5
1975	0.53	0.47	2.3	0.97	0.03	37.0
1976	0.96	0.04	27.9	0.99	0.01	85.5
1977	0.96	0.04	26.2	0.99	0.01	73.0
1978	0.95	0.05	23.8	0.99	0.01	57.9
1979	0.93	0.07	22.7	0.99	0.01	76.2
1980	0.93	0.07	20.5	0.99	0.01	103.0
1981	0.96	0.04	40.0	0.99	0.01	113.8
1982	0.97	0.03	50.1	0.99	0.01	112.5
1983	0.97	0.03	56.1	0.99	0.01	108.0
1984	0.98	0.02	74.4	0.99	0.01	139.8
1985	0.99	0.01	112.7	0.99	0.01	128.4

Source: Agriculture Canada databank.

Table N9 - Composition of Canada Beef Net Exports to the U.S.
millions of pounds in carcass weight

	Western Canada				Eastern Canada			
	fresh & frozen	cured	canned	total	fresh & frozen	cured	canned	total
1967	6.0	0.0	-0.0	6.0	15.7	-17.7	-0.0	-1.9
1968	10.6	0.3	-0.0	10.9	42.0	-15.0	-0.0	27.0
1969	6.2	0.3	-0.0	6.5	58.7	-11.2	0.0	47.5
1970	15.6	0.4	-0.0	16.0	106.4	-10.8	-0.1	95.5
1971	10.7	0.2	-0.0	10.9	67.1	-13.5	0.0	53.6
1972	2.2	-0.1	0.0	2.1	40.2	-11.8	-0.0	28.4
1973	1.6	0.5	0.0	2.1	37.6	-7.9	-0.1	29.6
1974	1.5	0.8	-0.0	2.2	33.1	-1.4	-0.0	31.7
1975	-1.2	1.1	0.0	-0.1	24.5	0.9	-0.0	25.5
1976	24.2	1.0	0.0	25.2	57.0	0.5	-0.1	57.4
1977	24.0	0.9	-0.0	24.9	58.3	0.3	0.0	58.6
1978	21.5	0.9	0.0	22.4	42.2	0.2	0.0	42.4
1979	20.3	1.4	0.0	21.6	66.9	0.7	-0.0	67.6
1980	16.3	1.2	-0.0	17.5	91.0	0.6	0.0	91.7
1981	32.3	1.1	-0.0	33.4	94.6	0.4	0.0	95.0
1982	45.0	0.8	0.0	45.8	90.5	0.5	-0.0	91.0
1983	50.0	1.0	0.0	51.0	81.0	0.9	-0.0	81.9
1984	59.3	0.9	-0.0	60.2	96.5	0.7	-0.0	97.2
1985	98.0	0.9	-0.0	98.9	84.2	0.5	-0.0	84.8

Source: Agriculture Canada databank.

Table N10 - Composition of Western Canada Pork Import from the U.S.

	relative proportion of				
	fresh ham	fresh & frozen pork	cured pork	canned pork	total imports (mill lbs)
1967	0.15	0.83	0.02	0.00	5.2
1968	0.16	0.83	0.00	0.00	8.6
1969	0.33	0.66	0.00	0.00	13.2
1970	0.52	0.47	0.01	0.00	3.0
1971	0.41	0.51	0.07	0.01	0.5
1972	0.19	0.79	0.02	0.00	5.6
1973	0.15	0.84	0.01	0.00	9.5
1974	0.11	0.87	0.02	0.00	19.0
1975	0.17	0.81	0.02	0.00	30.0
1976	0.15	0.83	0.02	0.00	77.9
1977	0.12	0.86	0.02	0.00	86.3
1978	0.10	0.88	0.02	0.00	49.6
1979	0.08	0.89	0.03	0.00	26.3
1980	0.05	0.90	0.05	0.00	9.4
1981	0.15	0.79	0.05	0.00	8.7
1982	0.08	0.81	0.11	0.00	4.3
1983	0.13	0.78	0.09	0.00	4.8
1984	0.25	0.50	0.24	0.00	1.9
1985	0.09	0.34	0.56	0.00	1.2

Source: Agriculture Canada databank.

Table N11 - Composition of Western Canada Pork Exports to the U.S.

	relative proportion of				
	fresh ham	fresh & frozen pork	cured pork	canned pork	total exports (mill lbs)
1967	0.71	0.22	na	na	28.6
1968	0.70	0.24	0.06	0.00	31.4
1969	0.81	0.12	0.07	0.00	27.6
1970	0.65	0.30	0.05	0.01	38.8
1971	0.63	0.32	0.04	0.01	49.9
1972	0.60	0.33	0.07	0.00	43.1
1973	0.51	0.42	0.06	0.00	45.3
1974	0.58	0.34	0.08	0.00	32.6
1975	0.61	0.23	0.16	0.00	13.7
1976	0.54	0.25	0.21	0.00	10.5
1977	0.52	0.22	0.26	0.00	8.0
1978	0.28	0.44	0.27	0.00	9.1
1979	0.23	0.48	0.29	0.00	9.4
1980	0.23	0.60	0.14	0.02	17.9
1981	0.25	0.54	0.13	0.08	19.0
1982	0.28	0.54	0.10	0.09	29.7
1983	0.32	0.53	0.10	0.05	31.5
1984	0.29	0.65	0.05	0.00	71.4
1985	0.25	0.67	0.08	0.00	115.5

Source: Agriculture Canada databank.

Table N12 - Composition of Western Canada Pork Net Exports to the U.S. millions of pounds in carcass weight

	fresh ham	fresh & frozen pork	cured pork	canned pork	total
1967	19.6	2.1	na	na	23.4
1968	20.4	0.4	2.0	0.0	22.7
1969	17.9	-5.4	1.8	0.1	14.4
1970	23.5	10.1	1.9	0.4	35.8
1971	31.4	15.5	2.0	0.6	49.4
1972	24.7	9.8	2.7	0.2	37.4
1973	21.8	11.1	2.7	0.2	35.8
1974	16.7	-5.4	2.2	0.1	13.6
1975	3.2	-21.0	1.4	0.0	-16.3
1976	-5.9	-62.2	0.6	0.0	-67.5
1977	-6.5	-72.1	0.2	-0.0	-78.3
1978	-2.4	-39.5	1.3	0.0	-40.5
1979	0.1	-19.0	1.9	0.0	-16.9
1980	3.7	2.3	2.1	0.4	8.5
1981	3.4	3.3	2.0	1.6	10.3
1982	7.9	12.4	2.5	2.5	25.4
1983	9.5	13.1	2.7	1.4	26.7
1984	20.3	45.8	3.4	0.0	69.4
1985	28.7	77.0	8.6	0.0	114.3

Source: Agriculture Canada databank.

Table N13 - Composition of Eastern Canada Pork Import from the U.S.

	relative proportion of				
	fresh ham	fresh & frozen pork	cured pork	canned pork	total imports (mill lbs)
1967	0.19	0.34	0.46	0.01	22.8
1968	0.20	0.43	0.38	0.00	29.0
1969	0.24	0.54	0.23	0.00	55.0
1970	0.19	0.39	0.43	0.00	20.9
1971	0.10	0.47	0.44	0.00	14.2
1972	0.19	0.58	0.23	0.00	29.0
1973	0.20	0.61	0.20	0.00	33.3
1974	0.28	0.58	0.14	0.00	44.3
1975	0.31	0.60	0.09	0.00	63.4
1976	0.29	0.64	0.08	0.00	114.3
1977	0.17	0.75	0.09	0.00	112.5
1978	0.11	0.78	0.11	0.00	64.9
1979	0.07	0.78	0.15	0.00	42.6
1980	0.06	0.67	0.27	0.00	27.4
1981	0.08	0.74	0.18	0.00	30.8
1982	0.05	0.83	0.12	0.00	24.9
1983	0.06	0.76	0.17	0.01	28.7
1984	0.06	0.76	0.19	0.00	16.7
1985	0.02	0.76	0.22	0.00	12.3

Source: Agriculture Canada databank.

Table N14 - Composition of Eastern Canada Pork Exports to the U.S.

	--------- relative proportion of --------				
	fresh ham	fresh & frozen pork	cured pork	canned pork	total exports (mill lbs)
1967	0.65	0.10	0.19	0.06	26.6
1968	0.67	0.08	0.21	0.04	25.1
1969	0.71	0.05	0.20	0.04	23.0
1970	0.67	0.08	0.21	0.04	22.1
1971	0.64	0.12	0.19	0.04	19.0
1972	0.60	0.18	0.20	0.02	19.2
1973	0.42	0.38	0.13	0.08	23.2
1974	0.62	0.12	0.19	0.07	16.0
1975	0.69	0.17	0.10	0.03	17.1
1976	0.61	0.26	0.13	0.00	12.1
1977	0.55	0.35	0.10	0.00	14.8
1978	0.56	0.39	0.05	0.00	38.5
1979	0.49	0.48	0.03	0.00	80.3
1980	0.48	0.50	0.01	0.00	152.3
1981	0.46	0.52	0.02	0.00	155.5
1982	0.44	0.55	0.01	0.00	219.5
1983	0.42	0.56	0.02	0.00	212.0
1984	0.37	0.61	0.02	0.00	242.9
1985	0.35	0.64	0.01	0.00	259.2

Source: Agriculture Canada databank.

Table N15 - Composition of Eastern Canada Pork Net Exports to the U.S.
millions of pounds in carcass weight

	fresh ham	fresh & frozen pork	cured pork	canned pork	total
1967	12.7	-5.1	na	na	3.8
1968	11.2	-10.5	-5.8	1.1	-3.9
1969	3.3	-28.3	-7.9	0.9	-32.0
1970	11.0	-6.4	-4.3	0.9	1.2
1971	10.8	-4.3	-2.5	0.9	4.9
1972	6.1	-13.4	-2.8	0.3	-9.8
1973	3.2	-11.3	-3.6	1.6	-10.1
1974	-2.4	-23.8	-3.2	1.0	-28.3
1975	-7.9	-35.3	-3.7	0.5	-46.4
1976	-25.5	-69.7	-7.1	0.0	-102.2
1977	-10.5	-79.1	-8.1	-0.0	-97.6
1978	14.4	-35.4	-5.4	-0.0	-26.4
1979	36.6	4.9	-3.9	0.1	37.7
1980	71.9	58.1	-5.5	0.4	124.9
1981	68.4	58.8	-2.8	0.3	124.7
1982	94.5	100.0	0.1	-0.0	194.6
1983	86.9	97.7	-1.3	-0.1	183.2
1984	89.4	136.1	0.7	0.1	226.2
1985	89.7	156.5	0.8	0.0	246.9

Source: Agriculture Canada databank.

Table N16 - U.S. Tariffs on Meat Imports from Canada
cents per pound

	Beef		Pork			Lamb
	fresh & frozen (a)	cured (a)	fresh & frozen (b)	cured (b)	canned (b)	fresh & frozen
1966	3.0	3.0	1.25	2.0	3.0	3.5
1967	3.0	3.0	1.25	2.0	3.0	3.5
1968	3.0	3.0	1.0	2.0	3.0	3.1
1969	3.0	3.0	1.0	2.0	3.0	2.8
1970	3.0	3.0	0.8	2.0	3.0	2.4
1971	3.0	3.0	0.7	2.0	3.0	2.0
1972	3.0	3.0	0.5	2.0	3.0	1.7
1973	3.0	3.0	0.5	2.0	3.0	1.7
1974	3.0	3.0	0.5	2.0	3.0	1.7
1975	3.0	3.0	0.5	2.0	3.0	1.7
1976	3.0	3.0	0.5	2.0	3.0	1.7
1977	3.0	3.0	0.5	2.0	3.0	1.7
1978	3.0	3.0	0.5	2.0	3.0	1.7
1979	3.0	3.0	0.5	2.0	3.0	1.7
1980	2.5	2.5	free	1.0	3.0	0.5
1981	2.0	2.0	free	1.0	3.0	0.5
1982	2.0	2.0	free	1.0	3.0	0.5
1983	2.0	2.0	free	1.0	3.0	0.5
1984	2.0	2.0	free	1.0	3.0	0.5
1985	2.0	1.5	free	1.0	3.0	0.5
1986	2.0	1.5	free	1.0	3.0	0.5

Notes: (a) Tariff is 10% if the price is above 30 centsper pound.
From August 1974 to August 1975, quota of 17 mills. lbs. Continued to December 1975.
(b) From August 1974 to August 1975, quota of 36 mills. lbs.

Source: Agriculture Canada, Livestock Market Review, various issues.

Table N17 - Canadian M.F.N. Tariffs on Meat Imports
cents per pound or as specified

	Beef		Pork			Lamb & mutton
	fresh & frozen (a)	cured (a)	fresh & frozen (b)	cured (b)	canned (b)	fresh & frozen
1966	3.0	1.0	1.25	1.75	na	6.0
1967	3.0	1.0	1.25	1.75	na	6.0
1968	3.0	1.0	1.1	1.75	na	6.0
1969	3.0	1.0	0.95	1.75	na	6.0
1970	3.0	1.0	0.5	1.75	na	6.0
1971	3.0	1.0	0.5	1.75	na	6.0
1972	3.0	1.0	0.5	1.75	na	6.0
1973	3.0	1.0	0.5	1.75	15 %	4.0
1974	3.0	1.0	0.5	1.75	15 %	4.0
1975	3.0	1.0	0.5	1.75	20 %	6.0
1976	3.0	1.0	0.5	1.75	20 %	6.0
1977	3.0	1.0	0.5	1.75	20 %	6.0
1978	3.0	1.0	0.5	1.75	15 %	6.0
1979	3.0	1.0	0.5	1.75	15 %	6.0
1980	2.5	1.0	free	1.0	15 %	5.6
1981	2.0	1.0	free	1.0	15 %	5.3
1982	2.0	1.0	free	1.0	15 %	4.9
1983	2.0	1.0	free	1.0	15 %	4.9
1984	2.0	1.0	free	1.0	15 %	4.1
1985	2.0	1.0	free	1.0	15 %	4.1
1986	2.0	1.0	free	1.0	15 %	4.1

Notes: (a) Global quota of 125.8 mills. lbs for the period August 1974 to August 1975. Quota extended to December 1975.
(b) Free from February 1973 to December 1973, and from May 1976 to December 1979.

Source: Agriculture Canada, Livestock Market Review, various issues.

Table N18 - Rail Rates for Cattle, Swith Current, Sask. to Midhurst, Ont.
dollars per cwt

1972	1	3.47	3.47	3.47	3.47
1973	1	3.47	3.47	3.47	3.47
1974	1	3.47	3.47	3.47	3.47
1975	1	4.52	4.52	4.76	4.76
1976	1	4.76	4.76	4.76	5.35
1977	1	5.35	5.35	5.35	5.21
1978	1	5.35	5.54	5.54	5.54
1979	1	5.54	5.54	5.54	5.8
1980	1	5.37	6.9	6.9	6.9
1981	1	6.9	6.9	8.02	7.36
1982	1	8.02	6.56	6.56	6.84
1983	1	6.56	6.95	6.95	6.95
1984	1	6.95	7.3	7.54	7.54
1985	1	7.3	7.3	7.3	8.5
1986	1	7.59	7.59	7.59	8.5

Source: Canadian Freight Association, "Eastboun Tariffs."

Table N19 - Live Cattle Freight Rail Rates, Calgary to Toronto
single deck rail car, dollars per car

1972	1	881.	881.	881.	881.
1973	1	881.	881.	881.	881.
1974	1	881.	881.	881.	881.
1975	1	968.	1218.	1260.	1344.
1976	1	1386.	1386.	1386.	1420.
1977	1	1420.	1420.	1420.	1385.
1978	1	1420.	1611.	1611.	1472.
1979	1	1472.	1611.	1611.	1638.
1980	1	1638.	1835.	1835.	1835.
1981	1	1835.	2001.	2099.	1919.
1982	1	2131.	1876.5	1876.5	2034.14
1983	1	1876.5	1989.09	1989.09	2135.85
1984	1	1989.09	2088.53	2088.53	2221.28
1985	1	2088.53	2172.08	2172.08	2432.3
1986	1	2172.08	2237.24	2237.24	2432.3
1987	1	2237.24			

Source: Alberta Agriculture, Agriculture Transportation,
Volume X, September 1986.

Table N20 - Rail Freight Rates for Dressed Meat, Calgary to Toronto
dollars per cwt, minimum weight 60,000 cwt

1972	1	3.5	3.5	3.5	3.5
1973	1	3.5	3.5	3.5	3.5
1974	1	3.5	3.5	3.5	3.5
1975	1	4.24	4.7	4.78	4.78
1976	1	5.05	5.05	5.09	5.16
1977	1	5.16	5.16	5.16	5.16
1978	1	5.39	5.39	5.39	5.39
1979	1	5.71	5.71	5.71	5.92
1980	1	6.32	6.52	6.52	6.52
1981	1	7.21	7.31	7.48	7.6
1982	1	8.51	8.51	8.51	8.51
1983	1	9.02	9.02	9.02	9.02
1984	1	9.17	9.47	9.47	9.47
1985	1	9.72	9.85	9.85	9.85
1986	1	9.85	9.85	9.85	9.85

Source: Alberta Agriculture, Agriculture Transportation, Volume X, September 1986.

Table N21 - Price Index for Railroad Freight in the U.S., 1984(12)=100

1974	5	38.5005	38.6339	42.0224	42.1024
	9	42.1558	42.1558	42.1558	42.2358
1975	1	42.2358	42.2358	42.2358	42.2358
	5	44.2369	44.2636	46.7449	46.8516
	9	46.8783	48.079	48.239	48.2657
1976	1	48.2924	48.3458	48.3458	49.4664
	5	49.9199	50.	50.	50.0267
	9	50.0533	50.9872	50.9872	51.1206
1977	1	52.8282	52.8282	52.8815	52.9082
	5	52.8815	52.8815	52.9349	52.9349
	9	52.9616	52.9616	52.9883	55.4429
1978	1	55.3895	55.3895	55.4162	55.4429
	5	55.4696	55.5496	57.4173	57.5507
	9	57.5774	57.5774	57.7108	61.6329
1979	1	61.8997	61.9263	62.1398	62.2198
	5	62.2465	62.9402	63.8741	64.5144
	9	65.2081	69.7172	69.9039	70.1174
1980	1	70.6243	71.4247	71.985	74.6264
	5	74.6264	75.3202	77.8281	78.0149
	9	79.6425	79.7759	79.936	80.1761
1981	1	83.7246	84.7652	85.7523	85.6457
	5	85.7523	86.5261	88.9007	88.9808
	9	89.0075	90.0747	90.1281	90.048
1982	1	93.4898	93.5432	93.5165	93.7033
	5	93.7566	93.7833	93.9167	93.9167
	9	93.89	93.89	93.89	93.89
1983	1	94.0501	94.8239	94.7972	94.7972
	5	94.8239	94.8239	94.8773	94.8773
	9	94.8506	95.2775	95.2775	95.3041
1984	1	98.9061	98.9061	98.9861	99.0128
	5	99.0128	99.0128	99.3596	99.3596
	9	99.3863	99.8932	99.8932	100.
1985	1	100.	100.	100.	100.
	5	100.	99.9	99.8	99.8
	9	99.8	99.8	99.8	99.8
1986	1	100.9	101.	101.	100.9
	5	100.9	100.9	101.1	101.1
	9	100.8	100.6		

Source: U.S. Department of Commerce, Survey of Current Business.
Note: Series available starting from 1969 in "Monthly Labour Review", June 1975.

Table N22 - Trucking Rates for Hauling Produce
Imperial Valley, CA to New-York, U.S. cents per mile

1980	1	84.7	84.7	86.8	88.6
	5	96.4	103.3	118.2	96.4
	9	93.2	94.8	88.1	79.9
1981	1	84.7	88.6	92.2	99.7
	5	86.6	130.	118.2	96.4
	9	91.6	91.6	85.	81.5
1982	1	96.1	94.	113.	96.1
	5	99.9	101.5	126.5	116.6
	9	98.3	90.	86.6	85.
1983	1	96.1	94.	113.	96.1
	5	99.9	101.5	126.5	116.6
	9	98.3	90.	86.6	85.
1984	1	116.9	105.3	103.7	107.2
	5	98.2	136.7	141.5	131.6
	9	92.8	85.2	88.	86.6
1985	1	97.8	105.3	103.7	105.3
	5	96.5	129.9	136.4	121.4
	9	101.6	99.9	94.8	90.
1986	1	103.7	107.2	107.2	109.2
	5	99.9	129.9	144.9	124.8
	9	108.1	101.6	96.5	94.8
1987	1	109.2	111.1		

Source: T.Q. Hutchinson, U.S.D.A., Office of Transportation.

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